1997 ACE PLAN

AVIATION CAPACITY ENHANCEMENT

U.S. Department
of Transportation

**Federal Aviation
Administration**

1997
Aviation Capacity Enhancement Plan

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EXECUTIVE SUMMARY

The purpose of the 1997 Aviation Capacity Enhancement (ACE) Plan, produced by the FAA Office of System Capacity (ASC), is to describe FAA initiatives that will enhance the capacity and performance of the National Airspace System (NAS). The Plan is divided into six chapters and four appendices:

- Chapter 1: The National Airspace System
- Chapter 2: Major Capacity Initiatives — Free Flight and NAS Modernization
- Chapter 3: Airport Development
- Chapter 4: Airspace Development
- Chapter 5: New Operational Procedures
- Chapter 6: Capacity Enhancing Technologies

Chapter 1 presents a broad overview of the current status of the NAS. From 1992 to 1996, the number of aircraft operations in the United States remained stable at about 62 million, while the number of aircraft operations at the top 100 U.S. airports increased from 25.3 to 26.6 million, a 5.1 percent increase. The increase in operations at the top 100 U.S. airports indicates that the busiest U.S. airports are getting busier, which will compound problems of congestion at these key airports unless airport and airspace capacity enhancements are made.

The FAA has established goals and performance measures to address four aspects of system capacity: delay, flexibility, predictability, and access. Delay, the traditional measure of NAS performance, held steady at 7.1 minutes per operation from 1992 to 1995, then increased to 7.5 minutes per operation in 1996. The number of operations delayed 15 minutes or more fell steadily from 1992 to 1995, then increased in 1996. The increase in average delay per operation and number of operations delayed was primarily due to unusually harsh storms that occurred in many areas of the U.S. in 1996. Due to well-focused efforts on the part of the FAA and airport authorities in expanding and enhancing airport facilities at many of the busiest airports in the U.S., delays have fallen while the number of operations at those airports increased. User flexibility is improving as a result of several FAA initiatives, such as the National Route Program (NRP) and reduced vertical and horizontal separation minima in oceanic airspace. Likewise, the FAA is working to improve system predictability through the development of integrated systems for the dissemination of weather data. Finally, FAA initiatives to improve access to its facilities and services include providing for and maintaining accessible public use airports, and enhanced communication procedures between the Department of Defense (DOD), the FAA, and air carriers to increase civilian access to special use airspace (SUA) when it is not in use by the military.

Chapter 2 describes the FAA's two major capacity enhancement initiatives - free flight and NAS modernization. Free flight and NAS modernization are interdependent initiatives which aim to provide the new technologies and procedures that will increase NAS efficiency. The main objective of free flight is to remove restrictions that hinder the efficient flow of traffic while maintaining or improving the current high level of safety. Transitioning to free flight requires both procedural and technological advances. The FAA has already initiated many of the procedural changes required for free flight, and is in the process of modernizing and replacing much of the equipment, computers, and software used to manage air traffic and assure safe operations. Flight 2000 is a demonstration project planned to test and validate free flight capabilities that will be made possible by modernized air traffic equipment and avionics.

Airport capacity enhancements are the subject of Chapter 3, Airport Development. There are approximately 3,300 airports in the U.S. that are considered significant to the capacity of the NAS. Of the top 100 airports, 61 are developing or have recently completed new runways or runway extensions to increase airport capacity. In this chapter, top priority capacity projects from six of the nine FAA regions are described. Since 1985, more than 40 airport capacity design team studies have been conducted. A table in this chapter indicates those recommendations that were implemented, and those that are no longer under consideration. Finally, ongoing airport capacity studies are described.

Chapter 4, Airspace Development, describes ongoing terminal and en route airspace analyses. Airspace development studies focus on restructuring airspace, rerouting traffic, or modifying arrival, departure, en route, or terminal flow patterns to relieve congestion and reduce delays. The FAA is currently involved in a large-scale analysis of the airspace on the west coast of the United States, as well as studies of the airspace around Salt Lake City, UT and Phoenix, AZ.

A cost-efficient alternative to airport and airspace development is modifying air traffic control procedures to improve the flow of aircraft in the en route and terminal area. Chapter 5 describes new and developing air traffic control procedures requiring minimal or no investment in new technology. For example, in the en route environment, the National Route Program is allowing pilots to fly more direct routes. In the oceanic environment, reduced horizontal and vertical separation minima will provide pilots with more flexibility and efficient routing. Additionally, less restrictive instrument approach procedures are being developed for the terminal environment.

Chapter 6, Capacity Enhancing Technologies, is divided into five areas: communications, navigation, surveillance, weather, and air traffic management. For each area, characteristics of the current system are described, followed by a description of planned enhancements and the key technologies that will make those enhancements possible. A table listing all of the currently funded capacity-enhancing technology projects is presented for each area.

Figure 1 summarizes the components of capacity enhancement and reflects the content and organization of the ACE Plan.

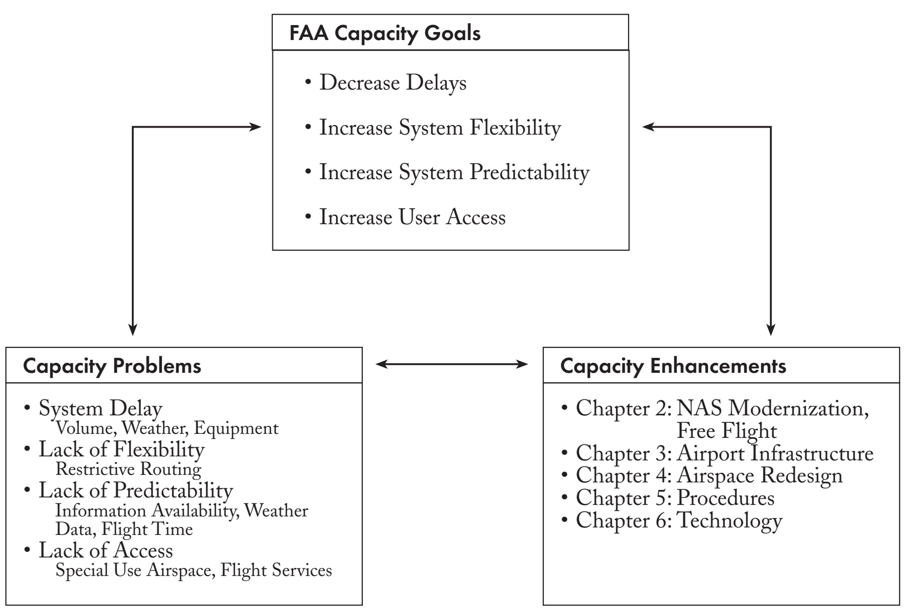

Figure 1.

Capacity Enhancement and ACE Plan Organization

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INTRODUCTION

The purpose of the Aviation Capacity Enhancement (ACE) Plan is to describe FAA initiatives that enhance the capacity and performance of the National Airspace System (NAS). The FAA's commitment to improving system capacity is captured by Goal 4 of the 1996 FAA Strategic Plan:

> *Meet the capacity needs for air and space transportation safely and efficiently through near-term actions targeted at specific problems and a long-term comprehensive program of research, planning, and investment matching user needs.*

The FAA Performance Plan, required by the Government Performance and Results Act (GPRA), supplements the FAA Strategic Plan by setting annual goals with measurable target levels of performance, and addresses specific aspects of capacity such as delay, flexibility, predictability and access. Improving aviation system capacity is a continuing dynamic process that evolves as user needs change and technology advances.

The ACE Plan is produced by the FAA Office of System Capacity (ASC). ASC identifies and evaluates capacity enhancements such as airport expansion, airspace redesign, and new operational procedures to ensure that the capacity of the U.S. Aviation System keeps pace with demand for aviation services. Although ASC is the only office with capacity enhancement as its primary mission, the activities of many offices within the FAA and other agencies such as the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD) play key roles in capacity enhancement. For example, within the FAA, the Office of Research and Acquisitions (ARA) enhances capacity through the development of advanced air traffic control technologies. The Office of Airports (ARP) provides grants and authorizes the collection and use of passenger facility charges (PFC) for funding capacity-enhancing airport development projects. Moreover, Air Traffic Services (ATS), of which ASC is one component, plays a critical role in maintaining and expanding capacity through the installation and maintenance of air traffic control equipment, and keeping air traffic flowing smoothly 24 hours a day, 365 days a year.

The ACE Plan is organized by chapters. *Chapter 1:The National Airspace System* describes changes in levels of aviation activity and FAA capacity goals for four aspects of system capacity — delay, flexibility, predictability and access. *Chapter 2: Major Capacity Initiatives — Free Flight and NAS Modernization* describes these interdependent efforts to improve aviation capacity through the development of new procedures and technologies. *Chapter 3: Airport Development* describes ongoing airport construction projects and airport capacity enhancement studies. *Chapter 4: Airspace Development* describes ongoing airspace analysis projects designed to achieve more efficient en route air traffic patterns in congested airspace. *Chapter 5: New Operational Procedures* describes new en route and terminal approach procedures which increase system capacity. *Chapter 6: Capacity Enhancing Technology* describes technological advances in the areas of communication, navigation, surveillance, weather, and air traffic management, which will improve the quality of aviation services and support implementation of free flight.

The appendices contain useful data on the aviation system. Appendix A provides various aviation activity statistics for the top 100 airports. Appendix B contains diagrams of the top 100 airports, with descriptions of new or planned construction. Appendix C is a list of acronyms, and Appendix D is a survey.

CHAPTER 1: THE NATIONAL AIRSPACE SYSTEM

Assuring that the capacity of the NAS can accommodate the growing demand for aviation services is critical to the Nation's economic future. In 1996, civil aviation provided almost 10.1 million jobs with total earnings of over $282 billion; economic activity generated by aviation during that year amounted to $974 billion. In the next 10 years, the demand for FAA aviation services will expand slowly, but steadily. This increased demand will be placed on an aviation system where key airports and terminal areas are already frequently congested.

This chapter provides information on current and projected aviation activity and on changes in flight delay and other measures of system capacity and performance. Aviation activity data indicate the demand on the system; system performance measures indicate the ability of the aviation system to accommodate the demand.

Aviation Activity

Aircraft operations, passenger enplanements, air cargo tonnage, and ARTCC traffic volume are all indicators of aviation activity and demand for FAA services. This section describes trends in these indicators.

U.S. Aircraft Operations and Passenger Enplanements

From 1992 to 1996 the number of aircraft operations in the United States remained stable at approximately 62 million. Over the same period, the number of air carrier and regional/commuter enplanements increased steadily from 506 million to 606 million, a 20 percent increase. By 2008, operations are expected to increase to 72.3 million (a 17 percent increase over 1996), and enplanements to 995 million (a 64 percent increase over 1996). The higher growth predicted for passenger enplanements relative to aircraft operations is primarily the result of higher load factors and larger seating capacity for air carrier aircraft. Figure 1-1 illustrates the trend in aircraft operations and passenger enplanements nationwide and at the top 100 airports in the United States.[1]

1. Based on 1996 passenger enplanements in the FAA's *Terminal Area Forecasts*.

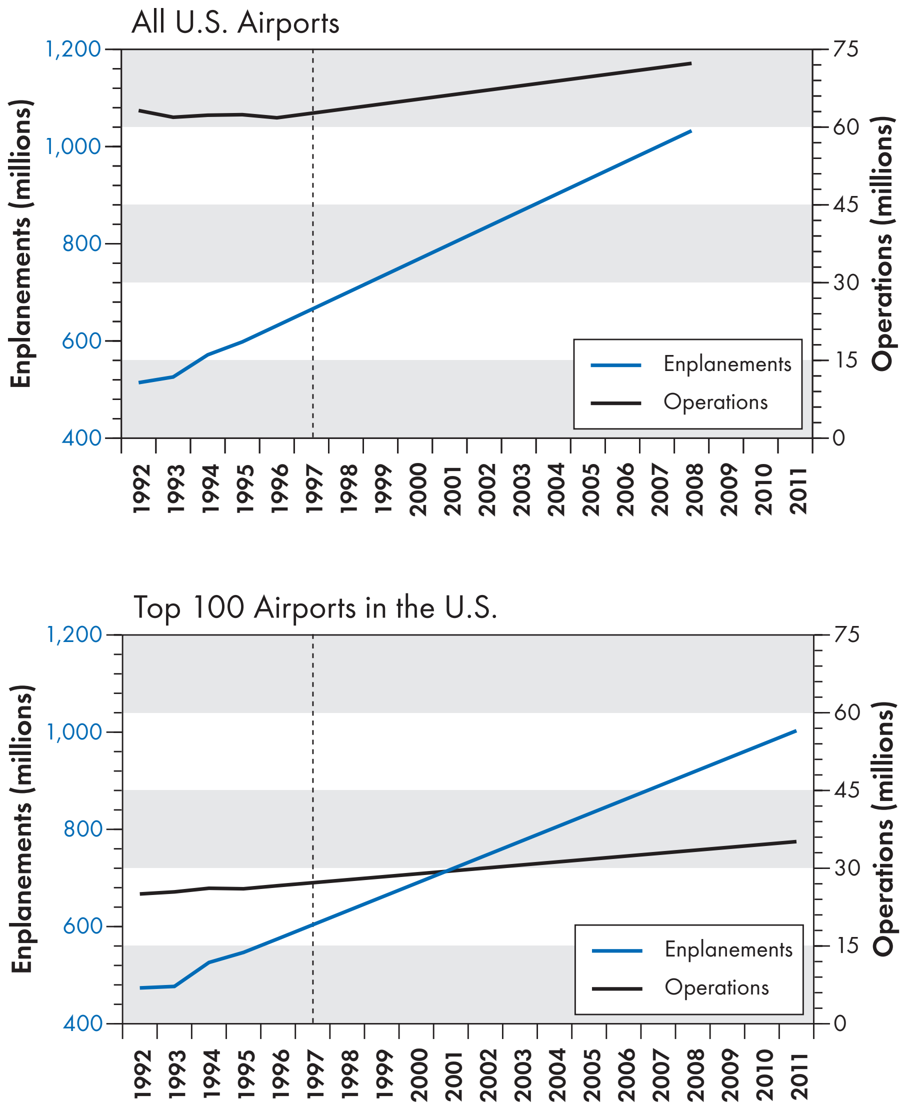

Figure 1-1.

Growth in U.S. Passenger Enplanements and Operations

Aircraft Operations and Passenger Enplanements at the Top 100 Airports

The top 100 airports in the United States, as measured by 1996 passenger enplanements, are shown in Figure 1-2. These 100 airports accounted for almost 95 percent of the 606 million passengers in the U.S. in 1996.

The number of aircraft operations at the top 100 airports increased from 25.3 million in 1992 to 26.6 million in 1996, a 5.1 percent increase. Over the same period, the number of air carrier and regional/commuter enplanements increased from 474 million to 575 million, a 21 percent increase. By 2011, aircraft operations at the top 100 airports are projected to increase to 35.1 million (a 32 percent increase over 1996), and enplanements to 1 billion (a 74 percent increase over 1996). Operations and enplanement data for 1994, 1995, and 1996 and forecasts of operations and enplanements for the top 100 airports in 2011 are included in Appendix A.

Air Cargo

Air cargo is increasingly important to the economy of the United States. In 1996, air cargo accounted for 23 percent of U.S. imports and 31 percent of U.S. exports by dollar value, up from 18 percent of imports and 28 percent of exports by dollar value in 1990.[2] Air transportation is a preferred mode of shipment for high-value, lightweight, perishable, and time-sensitive goods. Over the next seven years, world air cargo traffic is projected to grow at a faster rate than air passenger traffic.[3]

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Air cargo is transported in the baggage compartments of scheduled passenger aircraft and by all-cargo aircraft. In 1990 half of the air cargo tonnage in the U.S. was transported by all-cargo aircraft, and half of the tonnage was transported by passenger aircraft. By 1996, two-thirds of air cargo tonnage was transported by all-cargo aircraft, and only one third by passenger aircraft. Over the same time period, the tonnage carried by all-cargo carriers in the U.S. domestic market more than doubled. The increasing dominance of all-cargo carriers in the domestic market is projected to continue, increasing the number of all-cargo operations and demand for air traffic services at key cargo airports. However, most all-cargo flights are scheduled during off-peak periods and do not substantially contribute to airport congestion and delay problems. Table 1-1 lists the top 25 U.S. airports by cargo tonnage loaded and unloaded.

2. U.S. Department of Commerce, International Trade Administration
3. Boeing, from MergeGlobal 1997 World Air Freight Industry Analysis and Forecast.

Table 1-1.

Top 25 U.S. Airports by Total Cargo, 1996[4]

City	Airport	ID	Total Cargo*
Memphis, TN	Memphis International	MEM	1,934
Los Angeles, CA	Los Angeles International	LAX	1,719
Miami, FL	Miami International	MIA	1,710
New York, NY	John F. Kennedy International	JFK	1,636
Louisville, KY	Louisville Standiford Field	SDF	1,369
Anchorage, AK	Anchorage International	ANC	1,269
Chicago, IL	O'Hare International	ORD	1,260
Newark, NJ	Newark International	EWR	958
Atlanta, GA	Hartsfield Atlanta International	ATL	800
Dallas/Ft. Worth, TX	Dallas-Ft. Worth International	DFW	775
Dayton, OH	Dayton International	DAY	767
San Francisco, CA	San Francisco International	SFO	712
Oakland, CA	Metropolitan Oakland International	OAK	615
Indianapolis, IN	Indianapolis International	IND	609
Philadelphia, PA	Philadelphia International	PHL	494
Hounolulu, HI	Honolulu International	HNL	436
Boston, MA	Boston Logan International	BOS	406
Denver, CO	Denver International	DEN	390
Seattle-Tacoma, WA	Seattle-Tacoma International	SEA	388
Minneapolis-St. Paul, MN	Minneapolis-St. Paul International	MSP	361
Toledo, OH	Toledo Express	TOL	345
Detroit, MI	Detroit Metropolitan	DTW	320
Houston, TX	George Bush Intercontinental	IAH	310
Washington, DC	Washington Dulles International	IAD	309
Cincinnati, OH	Greater Cincinnati International	CVG	289

* Loaded and unloaded freight and mail in thousands of metric tons.

4. "The World's Airports in 1996: Airport Ranking by Total Cargo." Airports Council International. http://www.airports.org/cargo96.html

Traffic Volume in Air Route Traffic Control Centers (ARTCCs)

From FY96 to FY97 instrument flight rules (IFR) operations increased at 19 of the 20 Continental United States (CONUS) ARTCCs. The number of aircraft flying under IFR handled by ARTCCs totaled 40.8 million in FY97, an increase of 1.4 percent over FY96.

The five busiest ARTCCs in FY97 were: Chicago, Cleveland, Atlanta, Washington, and Indianapolis. Forecasts for FY08 indicate a change in ranking of the busiest ARTCCs to: Chicago, Cleveland, Washington, Atlanta, and Indianapolis. The ARTCCs with the highest average annual growth rates are Boston and Los Angeles, which are projected to grow by 2.3 and 2.2 percent respectively. Figure 1-3 is a map of the 20 CONUS ARTCCs. Figure 1-4 shows the number of operations by ARTCC for FY96 and FY97, and forecast operations for FY08.

System Performance Measures

Capacity-enhancing programs such as airport expansion and the development of more efficient air traffic control procedures are targeted at improving NAS performance. The FAA is developing performance goals to address the following four aspects of system capacity:

- Delay: the extent to which flights do not depart or arrive within the planned, expected, or scheduled time;
- Flexibility: the extent to which the air traffic control system allows users to optimize their operations based on their own objectives and constraints;
- Predictability: the variation in the air traffic management system as experienced by the user; and,
- Access: the ability of users to access airports, airspace, and services.

To ensure that capacity-enhancing efforts address these aspects of system performance, the FAA has, in addition to delay, begun to track flexibility, predictability, and access performance measures and establish targets for improvement. The measures will be used to monitor the capacity and performance of the aviation system and evaluate proposed capacity and performance enhancements. These actions are consistent with the Government Performance and Results Act (GPRA) of 1994, which requires all Federal agencies to set performance goals, tie their budget requests to those goals, and measure their success in achieving them. Figure 1-5 illustrates common capacity constraints and FAA goals and strategies for addressing those constraints.

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Figure 1-2.

Top 100 Airports Based on 1996 Passenger Enplanements

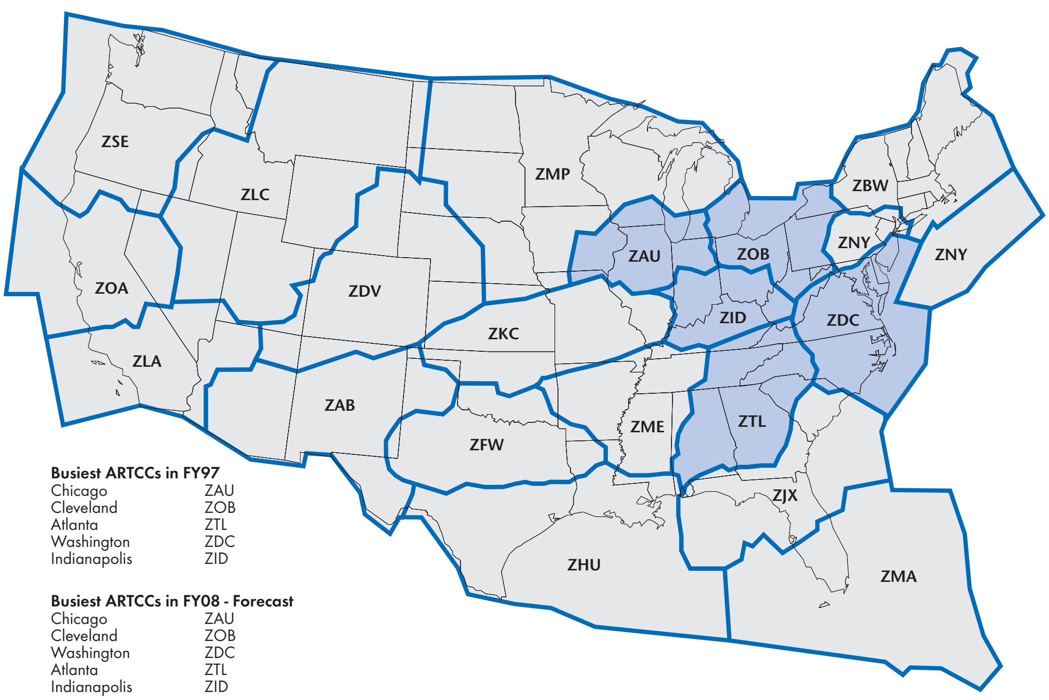

Figure 1-3.

CONUS Air Route Traffic Control Centers

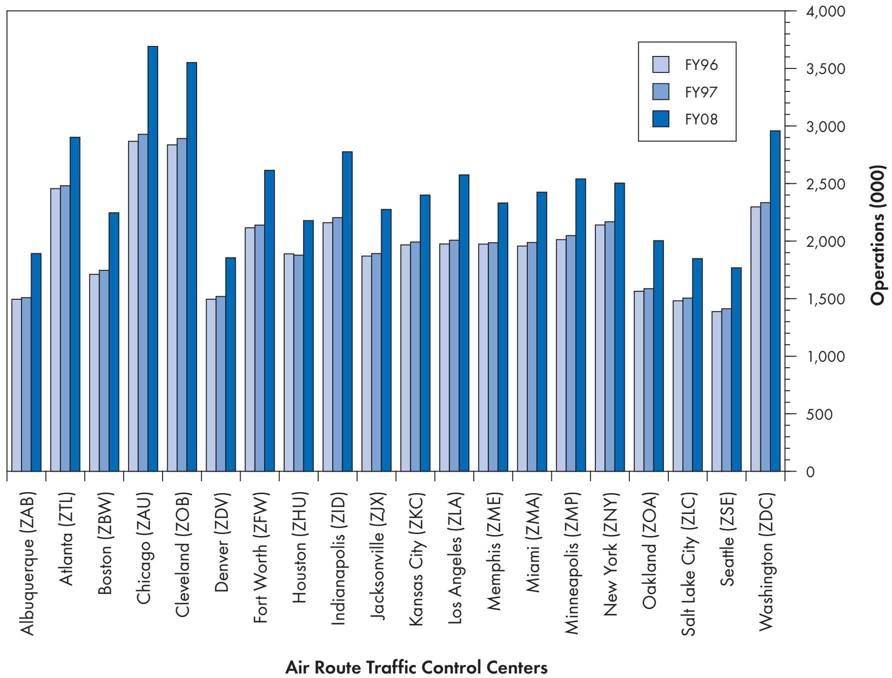

Figure 1-4.

Operations at CONUS ARTCCs

Capacity Constraints	FAA Capacity Goals	Strategies/Enhancements			
		Chapter 3 Airport Dev.	Chapter 4 Airspace Dev.	Chapter 5 Procedures	Chapter 6 Technology
Delay	**Reduce Delays**				
Air Traffic Volume	• Reduce the rates of volume related delays.	X	X	X	X
Equipment	• Reduce the rates of equipment related delays.				X
	• Accelerate NAS modernization by reducing the time it takes to acquire and field systems.				X
	• Put into operational service 100 percent of the integrated systems necessary to deliver the capabilities required to modernize the NAS, as documented in Version 3.0 of the NAS architecture.				X
Weather	• Develop and demonstrate the ability of new systems to decrease the rate of weather-related delays.				X
	• Reduce weather-related delays due to restrictive instrument approach procedures.			X	
Airports	• Increase system capacity attributable to airport infrastructure.	X			X
Lack of Flexibility	**Increase System Flexibility**				
Routing	• Reduce the amount of extra flight plan miles associated with ATC-preferred routes.			X	
	• Increase the percentage of flight segments flown off the ATC-preferred routes.			X	
Lack of Predictability	**Increase Predictability**				
Information availability	• Increase the level of information available to system users and involve them more frequently in operational decision making.			X	X
Weather Data	• Make improvements in obtaining and disseminating. weather products.		X	X	
Flight Time	• Improve in-flight and ground movement predictability.	X	X		
Lack of Access	**Increase User Access**				
Airspace	• Improve civilian access to special use airspace when not in use by military.		X	X	
Flight Services	• Reduce the average flight service call waiting time.				X
Airports	• Increase access to airports during IFR weather conditions.	X		X	X

Figure 1-5.

Capacity Constraints, Goals, and Strategies

Delay

The FAA uses two sources of delay data, the Air Traffic Operations Management System (ATOMS) and the Airline Service Quality Performance (ASQP) database. ATOMS, recorded by FAA personnel, is a record of aircraft delayed in excess of 15 minutes by cause (weather, terminal volume, center volume, closed runways or taxiways, and NAS equipment interruptions) during any phase of flight. Aircraft delayed by less than 15 minutes are not included in ATOMS. A delay is recorded if an aircraft is delayed 15 minutes or more during taxi out or 15 minutes or more in any en route center. Thus, an aircraft could be delayed 14 minutes during taxi out and 14 minutes in each ARTCC it passes through and not be recorded as a delay by ATOMS. Taxi-in delays are not counted.

Approximately 272,000 flights in 1996 were delayed 15 or more minutes, an increase of 14.7 percent from 1995.

ASQP data, controlled by DOT, are collected from airlines with one percent or more of the total domestic scheduled service passenger revenue. ASQP records delays as small as one minute by phase of flight (i.e., gate-hold, taxi-out, airborne, or taxi-in delays). ASQP is used primarily for consumer on-time performance reporting.

Delay by Cause: Weather, Equipment, and Volume

Approximately 272,000 flights in 1996 were delayed 15 or more minutes, an increase of 14.7 percent from 1995. The increase in flight delays is primarily due to adverse weather; unusually harsh storms resulted in the disruption of operations at numerous airports during several months of FY96. As a result, weather was attributed as the primary cause of 75 percent of operations delayed by 15 minutes or more in 1996, up from 72 percent in 1995.

Weather-related delays are largely the result of restrictive instrument approach procedures required in adverse weather to maintain safety. The FAA is developing more efficient IFR approach procedures, such as the missed approach procedure for simultaneous approaches described in Chapter 5. Weather-related delays are also caused by the absence of precision landing aids at certain airports, preventing aircraft from landing at those airports in IMC conditions. The FAA continues to install and upgrade instrument landing systems (ILSs) to support operations during conditions of reduced visibility. Improved technology for detecting adverse weather and disseminating weather data, described in Chapter 6, will also reduce weather-related delays.

Table 1-2 illustrates trends in the distribution of flights delayed 15 minutes or more by primary cause. Air traffic volume in the terminal area accounted for 18 percent of delays of 15 minutes or more in 1996, unchanged from 1995. Delays due to equipment failures fell from 3 percent in 1995 to 2 percent in 1996.

Table 1-2.

Distribution of Delay Greater Than 15 Minutes by Cause

Distribution of Delay Greater than 15 Minutes by Cause					
Cause	**1992**	**1993**	**1994**	**1995**	**1996**
Weather	65%	72%	75%	72%	75%
Terminal Volume	27%	22%	19%	18%	18%
Center Volume	0%	0%	0%	0%	0%
Closed Runways/Taxiways	3%	3%	2%	3%	3%
NAS Equipment	2%	2%	2%	3%	2%
Other	3%	2%	2%	4%	2%
Total Operations Delayed (000s)	**281**	**276**	**248**	**237**	**272**

Delays created by equipment outages will be reduced as components of the National Airspace System (NAS) infrastructure are replaced. Additional strategies to reduce delays include the following:

- Implement improved weather systems to mitigate the impacts of weather: Automatic Surface Observing System (ASOS) and Weather and Radar Processor (WARP). Test the Integrated Terminal Weather System (ITWS) (see Chapter 6).
- Deploy prototype automation tools such as the Center TRACON Automation System's (CTAS) Passive Final Approach Spacing Tool (FAST) (see Chapter 6). Complete implementation of the Display Channel Control Replacement (DCCR) program (see Chapter 6).
- Implement new procedures that take advantage of additional runway and airport capacity increases at various locations (see Chapter 5).
- Field infrastructure replacement programs that will reduce equipment-related delay. Display System Replacement (DSR) and the Standard Terminal Automation Replacement System (STARS) will replace an aging display and computing infrastructure that have caused several high-visibility delays (see Chapter 6).

Delay by Phase of Flight

Table 1-3 displays the average delay by phase of flight. More delays occur during the taxi-out phase than any other phase. From 1992 to 1995, taxi out delays held steady at around 6.9 minutes per flight, but increased to 7.3 minutes per operation in 1996. Airborne delays averaged 4.4 minutes per aircraft in 1996. To put this in perspective, there were approximately 6.9 million air carrier flights in 1996. With an average airborne delay of 4.4 minutes per aircraft, a total of almost 506,000 hours of airborne delay occurred that year, costing the airlines $809 million at an estimated $1,600[5] per hour. The delay per operation held steady at 7.1 minutes from 1992 to 1995, but increased to 7.5 minutes per operation in 1996. Like the increase in weather-related delays in 1996 displayed in Table 1-2, the increase in delay per operation is primarily due to unusually harsh storms that disrupted operations at numerous airports during several months of 1996.

Table 1-3.

Average Delay by Phase of Flight

Average Delay by Phase of Flight
(minutes per flight)

Phase	1992	1993	1994	1995	1996
Gate-hold	1.1	1.0	1.1	1.1	1.1
Taxi-out	6.9	6.9	6.8	6.8	7.3
Airborne	4.1	4.1	4.1	4.1	4.4
Taxi-in	2.2	2.2	2.2	2.2	2.3
Total	14.3	14.2	14.2	14.2	15.1
Minutes per Operation	7.1	7.1	7.1	7.1	7.5

5. The actual average aircraft operating cost is $1,587 per hour. The cost for heavy aircraft 300,000 lbs. or more is $4,575 per hour of delay, large aircraft under 300,000 lbs. and small jets, $1,607 per hour, and single-engine and twin-engine aircraft under 12,500 lbs., $42 and $124 per hour respectively. These figures are based on 1987 dollars.

Identification of Delay-Problem Airports

From 1992 to 1996, the proportion of air carrier flights delayed 15 minutes or more decreased at 33 of the 55 airports at which the FAA collects air traffic delay statistics. From 1995 to 1996, however, the proportion of flights delayed decreased at only 16 of the 55 airports. Table 1-4 lists the number of operations delayed 15 minutes or more per 1,000 operations from 1992 to 1996 at 51 of these airports. The proportion of flights delayed ranges from nearly 65 per 1,000 operations at Newark International Airport to 0.08 per 1,000 operations at Kahului Airport. Of the nine airports with more than 20 delays of 15 minutes or more per 1,000 operations in 1996, three were in the New York area.

From 1992 to 1996, the proportion of air carrier flights delayed 15 minutes or more decreased at 33 of the 55 airports at which the FAA collects air traffic delay statistics.

Figure 1-6 illustrates trends in operations and delays at ten of the busiest airports in the United States from 1992 to 1996. At ORD, DFW, ATL, and EWR, a smaller proportion of flights were delayed 15 minutes or more in 1996 than in 1992, while the number of operations increased. Delays at EWR, however, remain among the highest in the country. The only construction planned at EWR is a runway extension. At LAX, STL, and MSP, operations and delays were higher in 1996 than they were in 1992. At STL, a planned new runway will increase capacity. Likewise, at MSP a runway extension completed in October 1996, and a new runway in the planning stages, will increase capacity. At LAX, however, no significant airport improvements are expected in the near-term. Delay reductions will depend primarily on the development of more efficient airspace design and management.

Identification of Airports With More Than 20,000 Hours of Delay

Despite ongoing capacity improvements and reduced delay system-wide, certain airports continue to account for significant delay. In 1996, 26 airports each exceeded 20,000 hours of annual aircraft flight delay. With an average aircraft operating cost of about $1,600 per hour of delay, each of these 26 airports contributed at least $32 million dollars in annual delay costs. Assuming airport capacity is not improved, 31 airports are forecast to exceed 20,000 hours of annual aircraft flight delay each by the year 2006. Table 1-5 lists airports exceeding 20,000 hours of annual delay in 1996 and in 2006, assuming no capacity improvements.

It should be noted that hours of delay are a function of the number of operations and the average delay per operation. An airport with 300,000 operations and an average delay of four minutes per operation has 20,000 hours of delay. As the operations increase, the delay per operation could go down and the airport could still have more than 20,000 hours of delay.

Table 1-4.

Delays of 15 Minutes or More Per 1,000 Operations at Selected Airports

Airport	ID	1992	1993	1994	1995	1996
Newark International Airport	EWR	83.48	87.88	74.29	33.81	65.25
San Francisco International Airport	SFO	30.18	23.79	28.46	54.71	56.57
New York LaGuardia Airport	LGA	55.23	38.32	47.37	33.65	46.22
Chicago O'Hare International Airport	ORD	45.40	47.49	26.83	30.93	34.46
Lambert St. Louis International Airport	STL	14.96	19.54	22.72	33.87	34.04
New York John F. Kennedy International Airport	JFK	41.23	35.68	35.79	17.38	29.53
Boston Logan International Airport	BOS	34.61	39.23	29.79	22.15	26.37
Los Angeles International Airport	LAX	19.75	9.15	10.96	27.03	24.13
Hartsfield Atlanta International Airport	ATL	29.90	23.28	19.98	24.26	23.88
Dallas-Fort Worth International Airport	DFW	29.82	33.71	37.65	26.80	19.59
Philadelphia International Airport	PHL	18.47	18.75	20.85	6.89	17.95
George Bush Intercontinental Airport	IAH	7.86	8.06	5.52	10.79	11.45
Greater Cincinnati International Airport	CVG	5.95	6.38	6.40	4.88	10.38
Minneapolis-St. Paul International Airport	MSP	4.36	7.16	3.52	9.23	9.29
Detroit Metropolitan Wayne County Airport	DTW	11.24	9.05	6.95	10.52	9.10
Phoenix Sky Harbor International Airport	PHX	8.16	2.86	3.48	4.97	7.25
Washington Dulles International Airport	IAD	7.33	6.86	8.43	4.54	6.81
Miami International Airport	MIA	9.68	10.48	10.47	11.00	6.79
Chicago Midway Airport	MDW	2.12	2.98	3.10	4.03	6.70
Greater Pittsburgh International Airport	PIT	8.04	6.86	4.20	2.99	6.60
Charlotte/Douglas International Airport	CLT	6.19	3.79	4.90	4.75	6.55
Washington National Airport	DCA	11.03	9.34	10.44	5.61	6.53
Seattle-Tacoma International Airport	SEA	13.19	6.78	6.09	4.77	6.37
Cleveland Hopkins International Airport	CLE	1.58	2.37	1.62	3.74	4.68
Orlando International Airport	MCO	8.95	4.72	5.37	3.61	4.59
Tampa International Airport	TPA	4.29	3.88	3.22	1.62	4.43
Las Vegas McCarran International Airport	LAS	0.31	0.46	0.78	1.62	3.68
Baltimore-Washington International Airport	BWI	5.80	3.94	5.15	2.68	3.67
Salt Lake City International Airport	SLC	5.07	3.86	2.79	3.16	3.53
San Diego International Lindberg Field	SAN	3.03	3.91	2.51	4.41	3.31
San Juan Luis Muñoz Marín International Airport	SJU	0.56	0.30	0.71	5.29	2.92
Houston William P. Hobby Airport	HOU	2.74	3.49	2.96	3.36	2.57
Portland International Airport	PDX	1.78	1.94	2.41	1.47	2.41
Denver International Airport*	DEN	26.26	37.92	18.14	4.01	1.90
Raleigh-Durham International Airport	RDU	3.60	1.99	1.25	0.50	1.59
Fort Lauderdale-Hollywood International Airport	FLL	3.69	3.77	2.92	3.98	1.53
San Jose International Airport	SJC	1.74	0.38	0.72	1.03	1.39
Bradley International Airport	BDL	1.96	0.95	1.15	1.29	1.36
Ontario International Airport	ONT	1.33	1.24	0.96	1.96	1.06
San Antonio International Airport	SAT	0.20	0.10	0.35	0.87	0.99
Kansas City International Airport	MCI	0.75	1.26	1.82	2.22	0.98
Memphis International Airport	MEM	1.10	1.03	0.79	0.86	0.88
New Orleans International Airport	MSY	0.62	0.33	0.21	0.60	0.83
Nashville International Airport	BNA	2.91	2.72	1.55	1.46	0.73
Dayton International Airport	DAY	0.29	0.29	0.76	0.24	0.60
Indianapolis International Airport	IND	2.11	0.57	0.45	0.40	0.58
Palm Beach International Airport	PBI	1.02	0.81	0.39	0.57	0.46
Anchorage International Airport	ANC	0.34	0.74	0.29	0.51	0.33
Honolulu International Airport	HNL	0.13	0.19	0.08	0.17	0.19
Albuquerque International Airport	ABQ	0.69	0.27	0.21	0.09	0.14
Kahului Airport	OGG	0.13	0.05	0.03	0.20	0.08

* 1992 thru 1994 data is for Denver Stapleton Airport, which closed in 1995.
This accounts for the drastic reduction in delay for the 1995 data.

Table 1-5.

Airports Exceeding 20,000 Hours of Annual Delay in 1996 and 2006, Assuming No Additional Capacity Improvements

Annual Aircraft Delay in Excess of 20,000 Hours			
1996		2006	
Atlanta Hartsfield	ATL	Atlanta Hartsfield	ATL
Boston Logan	BOS	Boston Logan	BOS
		Baltimore-Washington	BWI
Charlotte/Douglas	CLT	Charlotte/Douglas	CLT
Cincinnati	CVG	Cincinnati	CVG
		Cleveland	CLE
Washington National	DCA	Washington National	DCA
Denver International	DEN	Denver International	DEN
Dallas-Ft. Worth	DFW	Dallas-Ft. Worth	DFW
Detroit	DTW	Detroit	DTW
Newark	EWR	Newark	EWR
Honolulu	HNL	Honolulu	HNL
Houston Intercont'l	IAH	Houston Intercont'l	IAH
New York John F. Kennedy	JFK	New York John F. Kennedy	JFK
Las Vegas	LAS	Las Vegas	LAS
Los Angeles	LAX	Los Angeles	LAX
New York La Guardia	LGA	New York La Guardia	LGA
Orlando	MCO	Orlando	MCO
		Chicago Midway	MDW
		Memphis	MEM
Miami	MIA	Miami	MIA
Minneapolis-Saint Paul	MSP	Minneapolis-Saint Paul	MSP
Chicago O'Hare	ORD	Chicago O'Hare	ORD
Philadelphia	PHL	Philadelphia	PHL
Phoenix	PHX	Phoenix	PHX
Pittsburgh	PIT	Pittsburgh	PIT
		San Diego	SAN
Seattle-Tacoma	SEA	Seattle-Tacoma	SEA
San Francisco	SFO	San Francisco	SFO
Salt Lake City	SLC	Salt Lake City	SLC
St. Louis	STL	St. Louis	STL

Source: FAA Office of Policy and Plans

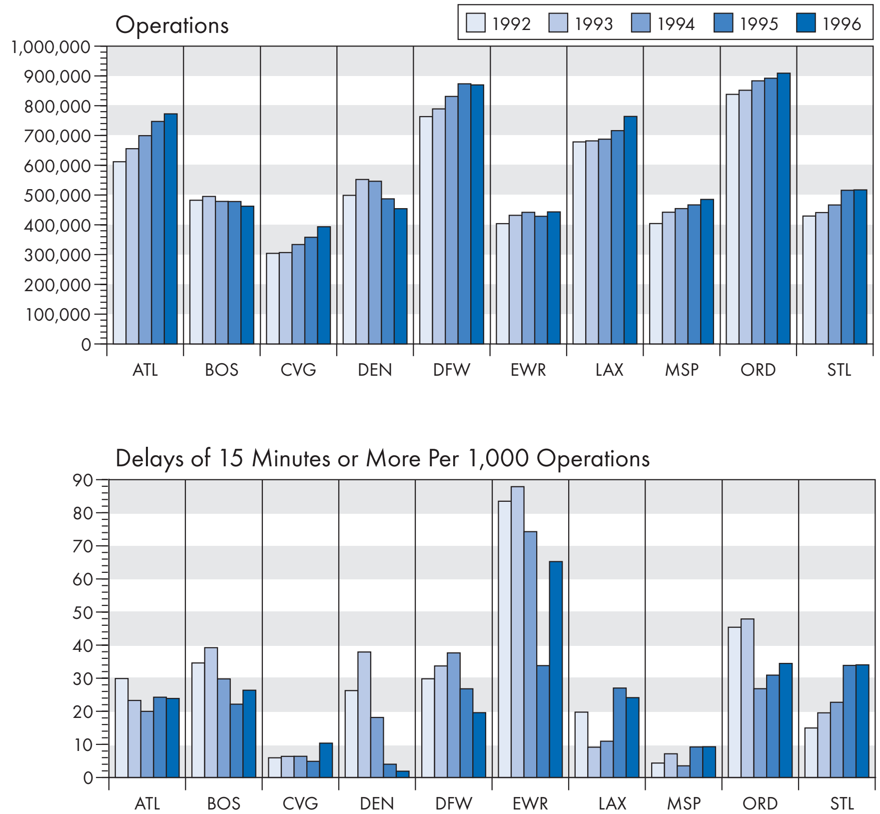

Figure 1-6.

Annual Operations and Delays of Fifteen Minutes or More Per 1,000 Operations at Ten of the Busiest Airports

Flexibility

Airlines, general aviation (GA) pilots, and other aviation system users expect more from the air traffic management system than the minimization of delay. They desire the capability to optimize their operations based on their own objectives and constraints, which vary by flight and user. Measuring the flexibility of the air traffic control system allows the FAA to evaluate its ability to permit users to adapt their operations to changing conditions. One measure of flexibility is the proportion of flights that are permitted to operate off ATC-preferred routes.

ATC-preferred routes are important tools that help air traffic controllers organize traffic flows around major airports. On a given day, approximately 30 percent of flights operate between cities with published ATC-preferred routes. Once airborne, approximately 75 percent of the route segments between cities with published ATC-preferred routes are actually flown off of the ATC-preferred routes. This ability to deviate from the ATC-preferred route structure represents a significant portion of the flexibility allowed to users in the air traffic management system.

The following are strategies the FAA is pursuing to increase system flexibility:

- Institute procedural changes to reduce unnecessary ATC-preferred routes (see Chapter 5).
- Implement Flight Management System (FMS) procedures at waypoints for the top 50 airports (see Chapter 5).
- Conduct annual audits of static and dynamic operating restrictions and eliminate unnecessary restrictions (see Chapter 5).
- Implement conflict probe prototypes to identify potential conflicts with more certainty, thereby avoiding unnecessary aircraft maneuvers and improving user flexibility (see Chapter 6).
- Replace the 200 nm constraint of the NRP (National Route Program) with Standard Instrument Departure/Standard Terminal Arrival Routes (SIDS/STAR) as ingress/egress points to the NRP (see Chapter 5).
- Improve flexibility in trans-oceanic flights by implementing Reduced Vertical Separation Minima (RVSM) and Reduced Horizontal Separation Minima (RHSM) (see Chapter 5).
- Relax the 250 knot speed limit below 10,000 feet in Class B airspace (see Chapter 5).

One of the most unpredictable portions of a flight is the time the aircraft spends on the ground, prior to take-off.

Predictability

Predictability is defined by the variation in the air traffic management (ATM) system experienced by the user. The majority of system users rely on schedules that determine when aircraft should take-off and land. These schedules are central to the operations of almost all commercial flights, driving crew scheduling, ground service operations, and other operational components. Even the smallest deviation from the planned schedule can cause drastic impacts. One of the most unpredictable portions of a flight is the time the aircraft spends on the ground, prior to takeoff. There are many factors that impact ground movement times, including level of demand, weather, and airport runway configuration.

A key strategy for increasing user predictability is improving the quality and quantity of information available to system users and involving them in interactive operational decision making. Additionally, the FAA will improve the technologies available for disseminating weather data, as weather is a significant contributor to the uncertainty in the ATM system. See Chapter 6 for more detailed information on technological enhancements related to weather and predictability (i.e., WARP, ITWS).

Access

The FAA plans to publish a minimum of 500 GPS approaches a year for the next three years.

Access to the ATM system, airports, airspace, and other FAA services is a basic need of all airspace users. The fundamental point where most users gain access to the ATM system is through airports. The FAA will increase access to the Nation's airports during IFR weather conditions by accelerating the publication of Global Positioning System (GPS) approach procedures to provide more accurate course guidance and increase access to airports in adverse weather conditions. The FAA plans to publish a minimum of 500 GPS approaches a year for the next three years.

An indicator of user access to the ATM system is the timeliness and quality of flight services such as pre-flight briefings on weather conditions, flight plan filing, and en route weather updates. Flight services are provided primarily by Flight Service Stations (FSS) (automated and non-automated) and Direct User Access Terminal Service (DUATS). In addition, pilots can obtain weather briefings through the Telephone Information Briefing System (TIBS) or private weather briefing vendors. Although the number of flight services provided by FSSs is expected to decrease from 1996 levels, the number of DUATS services is expected to increase (see Figure 1-7).

During adverse weather conditions when flight service information is most critical, users are often required to hold until a specialist is available. From 1994 to 1996 the average call waiting time fell from 34 to 30 seconds. To further improve timely access to important flight information, the FAA will begin rerouting calls from busy automated FSSs to facilities with shorter waiting times.

Another critical access issue is the utilization of special use airspace (SUA) by civilian aircraft. The FAA has been working closely with the Department of Defense to improve civilian access to SUA when the military is not utilizing the airspace for its critical mission. The FAA has begun operational trials of improved notification procedures and information transfer with respect to selected sections of SUA (see Chapter 5).

Additional FAA strategies to increase user access include the following:

- Supplement GPS navigation through independent operational testing and evaluation of the Wide Area Augmentation System (WAAS) (see Chapter 6).
- Implement the Operational and Supportability Implementation System (OASIS) to provide improved flight services (see Chapter 6).

The FAA also strives to increase user access by consistently improving airport infrastructure at the busiest airports, maintaining runway pavement in a satisfactory condition, and providing for and maintaining accessible public use airports.

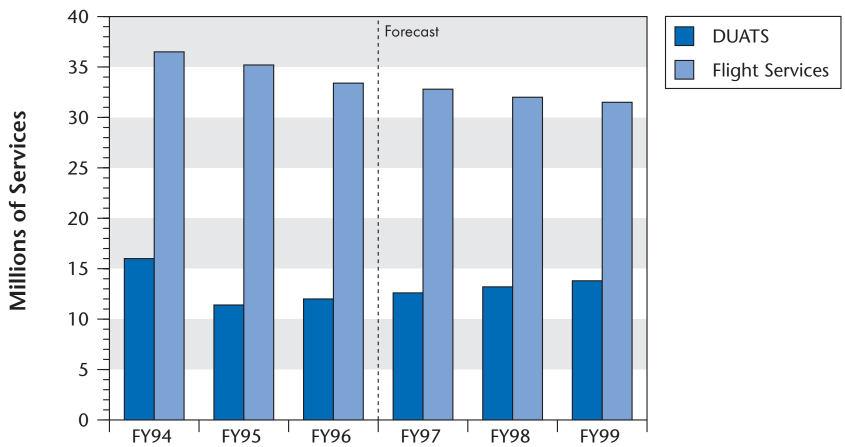

Figure 1-7.

Flight Service Activities

Chapter 2: Major Capacity Initiatives

Free Flight and NAS Modernization

The capacity of today's National Airspace System (NAS) is constrained by rules, procedures, and technologies that require pilots and air traffic controllers to conduct operations within narrow, often inefficient, guidelines. As air traffic continues to grow, these inefficiencies and their associated costs are compounded. Responding to these limitations, the FAA and the aviation industry are working together on two major interdependent capacity initiatives — free flight and NAS modernization. Flight 2000 is a demonstration project planned to test and validate the free flight capabilities made possible by modernized air traffic equipment and avionics. Implementation of Flight 2000 is dependent on available funding and the NAS modernization schedule.

Free Flight

Free flight is "a concept for safe and efficient flight operating capability under instrument flight rules (IFR) in which the operators have the freedom to select their path and speed in real time. Air traffic restrictions are imposed only to ensure separation, to preclude exceeding airport capacity, to prevent unauthorized flight through special use airspace (SUA), and to ensure the safety of flight. Restrictions are limited in extent and duration to correct the identified problem. Any activity which removes restrictions represents a move towards free flight."[1] The transition to free flight requires changes in philosophies, procedures, and technologies.

The principal philosophical change required for free flight is a shift from the concept of air traffic control (ATC) to air traffic management (ATM). ATM differs from ATC in several ways: the increased extent of collaboration between users and air traffic managers, greater flexibility for users to make decisions to meet their unique operational goals, and the replacement of broad restrictions with user-determined limits and targeted restrictions only when required.

The procedural changes required for free flight correspond directly to the change in philosophy from ATC to ATM. Under the current air traffic system, aircraft are frequently restricted to ATC-preferred routes, which may not be the routes preferred by the pilot or airline. Air traffic controllers direct pilots to change their direction, speed, or altitude to avoid adverse weather or traffic congestion. In contrast, free flight will grant pilots substantial

1. Final Report of RTCA Task Force 3, Free Flight Implementation, October 26, 1995.

discretion in determining their routes. Many decisions will be collaborative, taking advantage of the best information available to the pilot and air traffic manager to ensure safe, efficient flights.

The principal philosophical change required for free flight is a shift from the concept of air traffic control (ATC) to air traffic management (ATM).

The Radio Technical Commission for Aeronautics (RTCA) Task Force 3, a joint government/industry workgroup leading the free flight planning effort, identified 46 recommendations to promote free flight implementation. Some recommendations require extensive technological changes, such as the development of automatic dependent surveillance-broadcast (ADS-B) to improve surveillance coverage and accuracy. Technological changes required for free flight are described below under NAS Modernization, and more extensively in Chapter 6. Other recommendations involve primarily procedural modifications:

- Remove restrictions to allow for more direct routing;
- Increase civilian access to special use airspace when not in use by the military;
- Implement collaborative traffic flow management procedures and supporting mechanisms;
- Develop missed approach procedures for simultaneous approaches;
- Implement reduced vertical and horizontal separation minima;
- Remove the 250 knot speed limit below 10,000 feet in Class B airspace; and
- Transfer separation responsibility to aircraft on a case-by-case basis.

Several of these initiatives are currently being implemented, and are described in more detail in Chapter 5.

Modernization of the NAS will give users and service providers new abilities such as flexible departure and arrival routes and increased usage of preferred flight trajectories.

NAS Modernization

To achieve the free flight concept, the FAA is modernizing and replacing much of the equipment, computers, and software used to manage air traffic and assure safe operations. Modernization of the NAS will give users and service providers new abilities such as flexible departure and arrival routes and increased usage of preferred flight trajectories. Ultimately, NAS modernization will increase the flexibility, efficiency, and capacity of the NAS, improve traffic flow and weather predictability, and reduce user operating costs. The schedule and interdependencies of the many technological advances required for NAS modernization and free flight are outlined in the NAS Architecture.

The White House Commission on Aviation Safety and Security recommended the full implementation of NAS modernization by the year 2005. Achieving full modernization by 2005 will pose high-risk cost and performance challenges for the FAA and the airline industry due to technological uncertainties and aggressive scheduling. The FAA expects, however, that the Flight 2000 program (described in this chapter) will mitigate many risks of accelerated modernization through early, integrated research and testing of new technologies and procedures.

The principal NAS modernization changes affecting capacity are categorized into five functional areas: communications, navigation, surveillance, weather, and Air Traffic Management. The transition between the current and future NAS, and the new capabilities created by this change, are described below. The specific technologies within the five areas are described in Chapter 6.

Communications

In the future, communication between aircraft and ground facilities will require less radio voice communication and a greater use of electronic data transmitted to and from the flight deck via data link technology. Analog radios will be replaced by digital equipment for both voice and data. See Figure 2-1.

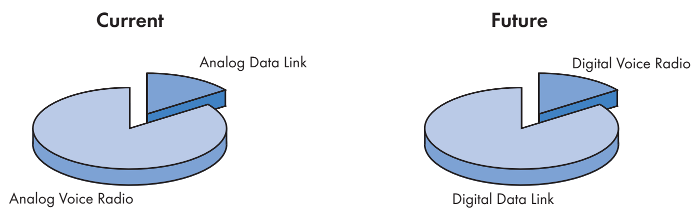

Figure 2-1.

Characteristics of Current and Future Communications Systems

Changes in the communication system will create the following capabilities:

- Integration of voice and data communications;
- More efficient use of the frequency spectrum;
- Improved quality and clarity of ATC messages to aircraft;
- Better flight and traffic information services (e.g., weather graphics, proximity traffic data);
- Seamless communications across all operational domains (airport, terminal, enroute, and oceanic);
- Information sharing with all NAS users; and
- An effective interchange network to support dynamic airspace usage.

Navigation

Navigation will become increasingly reliant on the satellite-based Global Positioning System (GPS) as represented by Figure 2-2. Existing ground-based stations will be decommissioned as new ground-based systems designed to augment the accuracy of GPS are deployed.

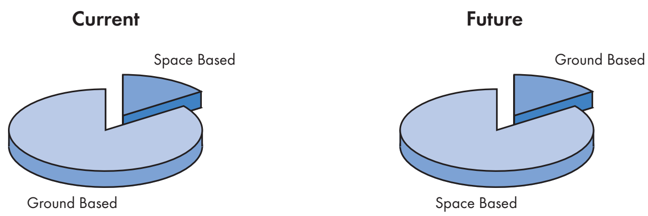

Figure 2-2.

Characteristics of Current and Future Navigation Systems

Augmented GPS will create the following capabilities:

- The movement toward user-preferred routing;
- Increased access to airports under IMC through more precision approaches; and
- Decommissioning of costly ground-based navigation and landing systems.

Surveillance

In the future, surveillance coverage and accuracy will be improved by replacing manually announced aircraft position reports with an onboard navigation system known as Automatic Dependent Surveillance (ADS). ADS automatically and continuously transmits position information that will be combined with radar images to ensure the system's accuracy. Analog radar will be replaced by digital radar as shown in Figure 2-3 below.

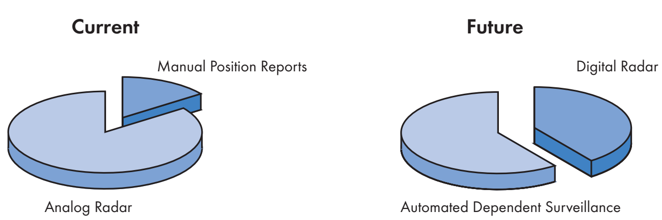

Figure 2-3.

Characteristics of Current and Future Surveillance Systems

The implementation of ADS and digital radar will create the following capabilities:

- Continuous surveillance of all positively controlled aircraft;
- More precise monitoring of aircraft separation and flight progression in oceanic airspace;
- Enhanced airport surface surveillance; and
- Reduced separation standards.

Weather

Today's fragmented weather gathering, analysis, and distribution systems will be enhanced by a more harmonized, integrated system as represented by Figure 2-4. Incremental improvements in weather detection sensors, processors, dissemination systems, and displays will also occur.

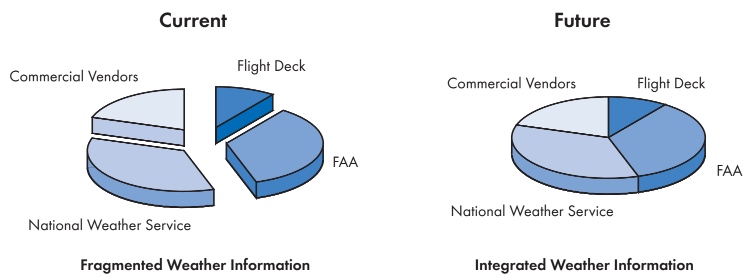

Figure 2-4.

Characteristics of Current and Future Weather Systems

Improved weather technologies will allow the following advancements:

- Common situational awareness among service providers and users through the use of integrated weather products;
- NAS-wide availability of distributed weather forecast data;
- Increased accuracy, display, and timeliness of weather information to service providers and users;
- Improved separation of aircraft from convective weather; and
- Integrated weather information into associated air traffic automation systems.

Air Traffic Management

Manual air traffic control procedures will be replaced by computer-based decision support systems (see Figure 2-5). These systems will improve the efficiency and effectiveness of NAS-wide information, thereby enhancing all phases of surface and flight operations.

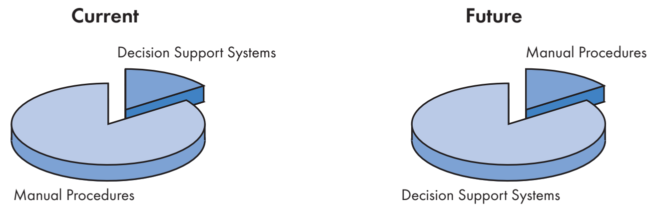

Figure 2-5.

Characteristics of Current and Future Air Traffic Management Systems

The use of advanced automation and decision support systems will enable the following:

- Greater collaboration of dynamic airspace management on problem resolution;
- Coordination among local, national, and international traffic flow managers;
- Increased use of airports by assisting in arrival sequencing and spacing, merging streams of traffic, and assigning aircraft to runways;
- Enhanced monitoring, strategy development, and NAS performance measurement;
- International harmonization of data;
- Improved acquisition and distribution of flight-specific data;
- Information updates for static and dynamic data (e.g., route structures, NAS infrastructure status, special use airspace restrictions, aircraft positions/trajectories);
- Improved accommodation of user preferences through improved traffic flow management, conflict detection/resolution, sequencing, and optimal trajectories;
- More flexible airspace structure by reducing boundary restrictions and creating dynamic sectors; and
- Automated information exchange between aircraft and decision support systems.

Flight 2000

The Flight 2000 initiative will demonstrate and validate a limited set of the capabilities planned for the free flight environment using the key technologies outlined in the NAS Architecture Version 3.0. The objectives of this initiative are to:

- Demonstrate safety and efficiency benefits of new technologies and improved procedures.
- Evaluate communication, navigation, and surveillance (CNS) transition issues.
- Streamline avionics development, certification, and installation, thereby driving down costs.
- Reduce risks for accelerated NAS modernization.
- Develop controller and pilot tools for transition to a free flight environment.

The Flight 2000 initiative will demonstrate and validate a limited set of the capabilities planned for the free flight environment using the key technologies outlined in the NAS Architecture.

The technical and operational tests will occur in Alaska and Hawaii and the oceanic airspace between the U.S. West Coast and Hawaii. Approximately 2,000 aircraft participating in Flight 2000 will be equipped with a new generation of advanced avionics that include GPS, ADS-B, data link, and cockpit display of traffic information. ATC facilities will be modernized with corresponding ground infrastructure necessary to support digital data link as well as advanced decision support systems (DSS), such as the oceanic conflict probe.

Validation flights in domestic and oceanic airspace will demonstrate the interoperability of these advanced technologies, DSS, and new procedures. On the airport surface, tests will be conducted to determine the effectiveness of systems to detect and communicate the movement of traffic. GPS routes, precision approach, and missed approach procedures will be developed, tested and published. During domestic flight operations, new procedures will be tested to determine when separation between participating aircraft can be safely reduced from current standards using enhanced surveillance provided via ADS-B position reports.

Aircraft flying oceanic routes will test the effectiveness of integrated ADS/GPS/DSS/data link systems to enhance air traffic control and monitoring and improve flexibility and access. Satellite data link will be evaluated as a prime means of ATC communication. New oceanic separation assurance procedures will be validated to determine when separation between participating aircraft can be safely reduced.

Certification is a prime component of Flight 2000 and the successful evolution to a modernized NAS. Certification activities for Flight 2000 will ensure that enabling technologies and associated operational procedures will continue to meet the FAA safety requirements, while reducing time and cost of approval.

CHAPTER 3: AIRPORT DEVELOPMENT

Airports are visible symbols of the economic well-being of the United States. To meet the capacity demands generated by a prosperous economy, it is essential to expand the Nation's airport infrastructure. In this chapter, the expansion and improvement of airports to increase aviation capacity are discussed.

Airport Capacity in the United States

There are approximately 3,300 airports[1] in the United States that are considered significant to the capacity of the NAS (see Table 3-1). These airports, by inclusion in the National Plan of Integrated Airport Systems (NPIAS), become eligible to receive grants under the Federal Airport Improvement Program (AIP). There are an additional 15,000 small or privately owned landing areas in the United States that are not eligible for AIP grants

Of the 3,300 significant U.S. airports, 411 are considered primary airports[2]. These airports account for 99.9 percent of all commercial enplanements. Delay problems are most prevalent at large-hub primary airports.

Financing of Airport Capacity Enhancements

Airport capacity enhancements funded by the FAA fall into three general categories: airfield improvements, facilities and equipment, and operational improvements.

Airfield Improvements

AIP grants are a significant funding source for airfield improvements. AIP grants are intended primarily to: stimulate capacity-enhancement projects such as the construction of runways, taxiways, and aprons; promote safety and security; help finance small and general aviation airports; and pay a significant part of noise and environmental mitigation cost. Between 1985 and 1995, AIP grants financed 14 percent of all capital spending at large commercial airports, 28 percent at medium-sized commercial airports, and 41 percent at small airports (small commercial airports as well as reliever and general aviation facilities).[3] In FY96, the FAA awarded more than $1.5 billion in AIP grants. Airport

1. **Airports** include landing areas developed specifically for helicopters and seaplanes as well as conventional fixed wing aircraft landing areas.
2. **Primary airports** are commercial service airports with more than 10,000 annual passenger enplanements.
3. http://www.faa.gov/ARP/app500/finalcom/eshome.htm

Table 3-1.

Distribution of Aviation Activity at U.S. Airports

Number of Airports	Airport Types	% of Commercial Enplanements	% of Aircraft
	AIP Eligible Airports		
411	Primary Commercial Service	99.9%	20.8%
29	*Large Hub*	*67.2%*	*1.3%*
42	*Medium Hub*	*22.2%*	*3.8%*
67	*Small Hub*	*7.1%*	*4.5%*
273	*Non Hub*	*3.4%*	*11.2%*
155	Other Commercial Service	0.1%	3.2%
320	Reliever	0.0%	30.0%
2,444	General Aviation	0.0%	37.5%
3,330	**Total**	**100.0%**	**91.5 %**
	Non-AIP Eligible Airports		
14,961	Low Activity Landing Areas	0.0%	8.5%

Primary airports are commercial service airports with more than 10,000 annual passenger enplanements.

Commercial Service Airports are defined as public airports receiving scheduled passenger service and having 2,500 or more enplaned passengers per year.

Hub is used by the FAA to identify very busy commercial service airports. For instance:

Large hubs are airports that account for more than one percent of passenger enplanements. Some large hub airports have very little passenger transfer activity (LaGuardia, Washington National, and San Diego International-Lingbergh Field, for example) while transfers account for more than half of the traffic at others (Atlanta, Pittsburgh, and St. Louis, for example). General aviation plays a relatively small role at most large hubs.

Medium hubs are airports that account for 0.25 percent to 1 percent of passenger enplanements. Medium hub airports have sufficient capacity to accommodate air carrier operations and a substantial amount of general aviation.

Small hubs are airports that account for 0.05 percent to 0.25 percent of passenger enplanements. These airports can have a great deal of general aviation activity, with an average of 135 based aircraft (locally owned-aircraft hangared or based at the airport).

Non-hub primary airports are commercial service airports that account for less than 0.05 percent of commercial passenger enplanements but more than 10,000 annually. These airports are heavily used by general aviation.

Other Commercial Service Airports enplane 2,500 to 10,000 passengers annually. These airports are used mainly by general aviation.

Reliever Airports are high-capacity general aviation airports designed to improve GA access to airports in major metropolitan areas.

GA **Airports** are airports that do not receive scheduled commercial service, have at least ten based aircraft, and are at least 30 minutes from the nearest NPIAS airport. The number of based aircraft criterion may be realized for remote locations or other mitigating circumstances. GA airports are generally distributed on a one-per-county basis in rural areas. GA airports are the most convenient source of air transportation for about 19 percent of the population and are particularly important to rural areas.

development is also funded through a combination of Passenger Facility Charges (PFCs), airport revenue and reserves, municipal bonds, commercial loans, and state and local grants.

Public agencies controlling commercial service airports, after receiving approval from the FAA, can charge enplaning passengers a $1, $2, or $3 facility charge. PFC revenues are used primarily for terminal development; they are also used for airport planning, runway, taxiway and apron infrastructure, and airport access. The PFC program currently generates approximately $1 billion annually for airport development. PFC revenues are concentrated at high activity airports. Ten airports generate almost 50 percent of total PFC revenue. Seven of the ten busiest airports are currently collecting PFCs. Thus, PFC revenues are concentrated at airports with the greatest capacity development and noise mitigation needs.

Facilities and Equipment

Full realization of the capacity benefits of new and extended runways and other airport improvements frequently requires the installation of equipment such as Instrument Landing Systems (ILS), Runway Visual Ranges (RVR), VHF Omnidirectional Ranges (VOR), approach lighting, and Precision Runway Monitors (PRM). This equipment is funded by the FAA's Facilities and Equipment (F&E) budget. Due to funding limitations, installation of equipment must be staggered to give priority to the needs of the most capacity-constrained airports.

Operational Improvements

Operational improvements to expand airport capacity, such as improved IFR approach procedures and reduced separation standards for arrivals, are primarily funded by the FAA's Research, Engineering, and Development (R,E&D) budget. See Chapter 5 for information on several operational improvements under development.

Airport Construction and Expansion

Airport development frequently entails the construction of new terminals, new and extended runways, and improved taxiway systems. In large metropolitan areas with frequent flight delays and limited airport expansion possibilities, other options must be explored. New airports, expanded use of existing commercial-service airports, civilian development of former military bases, and joint civilian and military use of existing military facilities are some of the additional options available for meeting expanding aviation needs.

Conversion of Military Airfields to Civilian Airport Facilities

To date, 20 military airfields have been converted to civil use airports under the DOD Base Realignment Closure program (BRAC). This has resulted in the addition of sixteen runways of lengths ranging from 8,000 feet to 12,000 feet and the replacement of two runways in the civil inventory. Eleven BRAC airports have participated in the Military Airport Program (MAP). The MAP, funded by an AIP set-aside, provides grants to current or former military airports with the potential to improve the capacity of the NAS. Airports remain eligible to participate in the MAP for five fiscal years following their initial designation as participants. There were twelve MAP participants in 1997, six reliever airports, five primary commercial service airports, and one other commercial service airport. Several MAP projects are described below.

In Austin, Texas, the conversion of Bergstrom Air Force Base will replace Robert Mueller Airport, which can no longer meet growing demand. The new airport opened for cargo service in June 1997 and will open for passenger service by May 1999.

The former Williams Air Force Base has been converted to a civil use reliever airport for Phoenix Sky Harbor International Airport. The airport was renamed Williams Gateway Airport. It will serve most categories of civil aircraft with its three runways ranging from 9,300 to 10,400 feet long. The additional airport will add over 290,000 potential annual aircraft operations to the Phoenix airport system.

The former Memphis Naval Air Station has been converted to a civil use reliever airport for Memphis International Airport. The airport was renamed Millington Municipal Airport. It will serve most categories of aircraft with its runway of 8,000 feet. The airport has a potential capacity of 205,000 annual operations.

Other MAP participants include: San Bernardino International Airport, California (a reliever for Los Angeles and Ontario) and Dade County-Homestead Regional, Florida (a reliever for Miami Airport).

Airport Enhancements for New Large Aircraft (NLA)

New Large Aircraft (NLA) offer the potential of meeting the expected increase in passenger volume in the foreseeable future. With seating capacities expected to be in the 600-800 passenger range and added cargo capacity, NLA may allow airports to provide increased service without major infrastructure alterations. In response to announced plans to build NLA by the year 2003, FAA has formed a NLA Facilitation Group, which will draw on internal and external expertise in airports, air traffic control, aircraft rescue and fire fighting, manufacturing, operations, security, and other relevant areas. This group will address the criteria and conditions under which NLA will operate in the United States.

To make use of existing airport runways, taxiways, ramp, and parking areas with minimal modifications, the maximum fuselage length and wingspan of the NLA must be limited to 80 meters, a figure which some NLA proposals already exceed. Other issues which need to be addressed include the turning radius, the effects of the landing gear on pavement, and the effects of engine thrust on other operations in the airport environment.

The operation of NLA may affect departure and landing separation, as well as ground handling procedures. Such issues as wake vortices and obstacle clearance must be reviewed and special handling procedures may need to be developed. These could include mandatory taxi routes, remote holding or remote gates during infrequent CAT II/III operations, and special accommodations for terminal use.

Construction of New Airports

The largest NAS capacity gains result from the construction of new airports. However, given the high cost of airport construction (e.g., more than $4 billion for the new Denver International Airport, which opened in 1995), building a new airport is not a common capacity enhancement technique. Currently, no new airports with the potential to significantly impact NAS capacity are being constructed, with the exception of construction required to convert Bergstrom Air Force Base into a civilian airport (see Conversion of Military Airfields above).

The largest NAS capacity gains result from the construction of new airports. However, given the high cost of airport construction, building a new airport is not a common capacity enhancement technique.

Construction of New Runways and Runway Extensions

The construction of new runways and extension of existing runways is the most direct and significant action to improve capacity at existing airports. Large capacity increases, under both visual flight rules (VFR) and instrument flight rules (IFR), result from the addition of new runways that are properly placed to allow additional independent arrival/departure streams.

Of the top 100 airports, 61 are developing or have recently completed new runways or runway extensions to increase airport capacity.

Of the top 100 airports (based on 1996 passenger enplanements), two completed runway construction projects in 1997. Memphis (MEM), the most significant gateway for U.S. international cargo, completed a new parallel runway, and Boise (BOI) completed a runway extension. Ten additional airports are presently constructing new runways or runway extensions. Of the top 100 airports, 61 are developing or have recently completed new runways or runway extensions to increase airport capacity. Table 3-2 lists new runways and runway extensions that were completed in 1997, are under construction, or are planned or proposed at the top 100 airports.

Of the 26 airports exceeding 20,000 hours of air carrier flight delay in 1996 (see Table 1-5), 17 are planning or constructing new runways or runway extensions. Twenty-one of the 31 airports forecast to exceed 20,000 hours of annual air carrier delay in 2006 are planning or constructing new runways or runway extensions.

Regional Top Priority Capacity Projects

Six of the nine FAA regions identified the following capacity enhancement projects (planned or underway) as their most important airport development project. Several of these initiatives are the result of recommendations from Airport Capacity Studies, conducted by FAA's Office of System Capacity.

Western Pacific Region

In accordance with the Phoenix Capacity Enhancement Plan completed in September 1989, a third runway is being constructed at the Phoenix Sky Harbor International Airport (PHX) with a target completion date of September 1999. The relocation of facilities that lie in the new runway's path is one of the most challenging aspects of this project. Replacement facilities for an Arizona Air National Guard complex are being constructed southwest of their current location. The existing airport surveillance radar must also be moved to accommodate runway construction. Upon completion, the third runway will help accommodate the increased airport operations and aviation needs forecast in the PHX Capacity Plan. This runway will prevent additional delays, increased aircraft operating costs and passenger travel times, and will provide the capability to perform simultaneous instrument operations.

Great Lakes Region

The Milwaukee General Mitchell International Airport plans a 700 foot long extension to runway 7L-25R. This capacity project, while a relatively minor alteration, will postpone the need for a third parallel runway until the year 2015. The $1.9 million project, scheduled for construction in 1998, will decrease commuter aircraft delays by 40 percent, thus yielding significant capacity benefits with a minimal investment.

Northwest Mountain Region

The Port of Seattle is planning major expansion for the Seattle-Tacoma International Airport (Sea-Tac), including a north unit terminal and a 8,500 foot long third parallel runway 2,500 feet west of Runway 16R/34L. The third parallel runway, to be completed by 2004, will improve the airfield capacity in adverse weather. Adverse weather currently restricts Sea-Tac operations to a single arrival stream 44 percent of the year. The additional runway would allow parallel dependent approaches 99 percent of the year. The total Airport Capital Improvement Program funding through FY2007 is $1.4 billion. The Airport Layout Plan was approved by the FAA on July 7, 1997, and the Port of Seattle has begun acquiring property needed for the planned construction.

Central Region

The new runway at Lambert-St. Louis is the Central Region's top priority capacity enhancement project. This project, being nearly ten years in the planning phase, has the potential to significantly reduce projected delays both at St. Louis and across the NAS. The estimated cost of the new runway is $850 million with the total expansion effort estimated to cost over $2 billion. The new runway will provide Lambert with the capability to conduct simultaneous independent IFR arrivals. The FAA Technical Center completed a performance analysis on the proposed expansion of Lambert and concluded that the expansion has the potential for system-wide savings of $5.1 billion in operational delay and $9.5 billion in passenger delay over the years 2005-2015. This represents approximately a 14 percent reduction in operational delay and an 18 percent reduction in passenger delays.

Southern Region

The Hartsfield Atlanta International Airport (ATL) Capacity Design Team recommended a commuter/GA runway complex in its March 1987 Airport Capacity Enhancement Plan. This concept was later modified to a 6,000-foot long fifth parallel commuter

Table 3-2.

New and Extended Runways – Completed in 1997, Under Construction, Planned, or Proposed

Airport	Runway	Est Cost ($M)	Operational Date	Completed in 97	Under Construction
Albany (ALB)	10/28 extension	5.8	2000		
	1R/19L parallel	7.5	2010		
Atlanta (ATL)	5th E/W parallel	420.0	2002		
Baltimore (BWI)	10R/28L parallel	n/a	2003		
Bergstrom (new Austin)	17L/35R parallel	46.0	1998		
	west runway renovation	10.0	1996		X
Boise(BOI)	10L/28R extension	8.0	1997	X	
	10R/28L Parallel	n/a	2010		
Boston (BOS)	14/32	n/a	n/a		
Charlotte (CLT)	18W/36W 3rd parallel	160.0	2001		
Chicago Midway (MDW)	4R/22L reconstruction	32.0	1997		X
Cleveland-Hopkins (CLE)	5R/23L replacement	180.0	2000		
	5L/23R extension	40.0	2005		
Port Columbus (CMH)	10L extension	7.9	1997		X
Dallas-Fort Worth (DFW)	18L/36R extension	25.0	2002		
	18R/36L extension	25.0	2002		
	18R/36L new parallel	268.0	2003		
	17C/35C extension	15.0	2000		
Denver Intl (DEN)	16R/34L parallel	75.0	2000		
Des Moines (DSM)	05 extension	21.5	2001		X
Detroit (DTW)	4/22 parallel	116.5	2001		
El Paso (ELP)	8L/26R parallel	30.0	2010+		
	22 extension	8.0	2000		
Fort Lauderdale (FLL)	9R/27L extension	300.0	2003		
Fort Myers (RSW)	6R/24L parallel	80.0	2002		
Grand Rapids (GRR)	18/36 extension	58.0	1997		X
Greensboro (GSO)	5L/23R parallel	n/a	2020		
	14/32 extension	27.0	2004		
Greer (GSR)	3R/21L parallel	65.0	2010		
	3L21R extension	34.1	1999		
George Bush Intl (IAH)	14R/32L extension	8.0	2000		
	8L/26R new parallel	95.0	2002		
	9R/27L parallel	n/a	n/a		
Jacksonville (JAX)	7R/25L parallel	50.0	2011		
Kahului (OGG)	2/20 extension	40.0	1999		
Kansas City (MCI)	1L/19R extension	12.0	n/a		
Las Vegas (LAS)	1L/19R reconstruction	50.0	1997		X
Little Rock (LIT)	4L/22R extension	31.0	1998		X
Louisville (SDF)	17R/35L parallel	59.0	1997		X
Lubbock (LBB)	8/26 extension	5.0	2005		
Memphis (MEM)	18L/36R new parallel		1997	X	
	18C/36C extension & reconst	103.0	2000		
Miami (MIA)	8/26 new parallel	180.0	2002		
Midland (MAF)	10/28 extension	5.0	2008		
Milwaukee (MKE)	7R/25L parallel	n/a	n/a		
	7L/25R extension	1.9	1998		
Minneapolis (MSP)	17/35 air carrier	175.0	2003		

Table 3-2.

New and Extended Runways – Completed in 1997, Under Construction, Planned, or Proposed

Airport	Runway	Est Cost ($M)	Operational Date	Completed in 97	Under Construction
Nashville (BNA)	2E/20E parallel	n/a	n/a		
	2R/20L extension	n/a	n/a		
New Orleans (MSY)	18/36 near parallel	400.0	2005		
	10/28 parallel	n/a	n/a		
Newark (EWR)	4L/22R extension	n/a	2000		
Norfolk (ORF)	5R/23L parallel	75.0	2005		
Oakland Metro (OAK)	11R/29L parallel	n/a	n/a		
	11/29 extension	n/a	n/a		
Oklahoma City (OKC)	17L/25R extension	8.0	2014		
	17R/35L extension	8.0	2014		
	17W/35W parallel	13.0	2004		
	13/31 extension	5.0	2005		
Orlando (MCO)	17L/35R 4th parallel	137.0	2002		
	17R/35L extension	n/a	n/a		
Palm Beach (PBI)	9L/27R extension	10.0	2000		
Philadelphia (PHL)	8/26 parallel-commuter	220.0	n/a		
	9L/27R relocation	n/a	n/a		
Phoenix (PHX)	7/25 3rd parallel	170.0	1999		
	8L/26R extension	7.0	2000		
Pittsburgh (PIT)	4th parallel 10/28	150.0	n/a		
	5th parallel 10/28	n/a	n/a		
Raleigh-Durham (RDU)	5R/23L extension	n/a	2005		
	3rd parallel	n/a	n/a		
Richmond (RIC)	16/34 extension	45.0	1997		X
Reno/Tahoe (RNO)	7/25 extension	n/a	n/a		
	34R extension	n/a	n/a		
Rochester (ROC)	4R/22L parallel	10.0	2010		
	4/22 extension	4.0	2000		
	10/28 extension	3.2	2000		
Lambert-St. Louis (STL)	New 12R/30L	850.0	2003		
	12R/30L extension	50.0	n/a		
San Antonio (SAT)	12L/30R reconstruction	20.0	2010		
	12N/30N new runway	400.0	n/a		
San Jose (SJC)	12L/30R extension	16.0	1999		
Santa Ana(SNA)	1/19R extension	n/a	n/a		
Sarasota-Bradenton (SRQ)	14L/32R parallel	10.0	2002+		
	14/32 extension	5.1	2002+		
Savannah (SAV)	9L/27R new parallel	20.0	2020		
Seattle-Tacoma (SEA)	16W/34W parallel	585.0	2004		
Spokane (GEG)	3L/21R	11.0	2010		
Syracuse (SYR)	10L/28R	55.0	n/a		
Tampa (TPA)	18W/36W 3rd parallel	n/a	n/a		
	9/27 extension	n/a	2010+		
	18L/36R extension	n/a	2005+		
Tucson (TUS)	11R/29L parallel	30.0	2005		
Tulsa (TUL)	18L/36R parallel	115.0	2005		
Washington Dulles (IAD)	1L/19R parallel	n/a	2009		
	12R/30L parallel	n/a	n/a		
Total of Available estimated costs:		$6,312.5M			

n/a = no data available at press time

runway, 4,200 feet south of existing runway 9R/27L. A December 1995 update of the Airport Capacity Enhancement Plan showed this runway would provide significant delay savings benefits at ATL. The city of Atlanta is currently purchasing land for the new runway. Construction is expected to begin in early 1998 and be completed in early 2002. This runway will allow triple simultaneous arrivals to ATL in instrument conditions using the new Precision Runway Monitor (PRM) technology. A runway dedicated to commuter aircraft arrivals will reduce airborne delay for these aircraft and air carrier aircraft operating on the four existing runways. A reduction in delays at a major hub airport such as ATL will reduce delays in the entire NAS.

Southwest Region

Due to the projected growth of handling one million operations annually before 2005, the Dallas/Fort Worth International Airport (DFW) is extending three of its seven runways and will begin construction of a new parallel runway, Runway 18R/36L (west of the existing north/south runways). This runway will significantly increase capacity in all weather conditions. The $208 million dollar project will be 5,800 feet from the closest runway and will allow independent approaches without PRMs. The runway is expected to be operational by 2003. DFW will be the first airport to offer four simultaneous parallel approaches and takeoffs under instrument conditions.

Eastern Region

The City of Philadelphia is well underway with the construction of a fourth runway for Philadelphia International Airport. This is especially important in the light of recent enhancements to it's hub service levels.

Airport Capacity Studies

As environmental, financial, and other constraints continue to restrict the development of new airports in the United States, increased emphasis has been placed on the redevelopment and expansion of existing airport facilities. The FAA's Office of System Capacity (ASC) forms Airport Capacity Design, Tactical Initiative, and Regional Design Teams to focus on maximizing the capacity at existing airports through improvements in runways and taxiways, navigational and guidance aids, and operational procedures. Table 3-3 lists the completed airport capacity, tactical initiative, and regional studies and the year in which they were published.[4]

Airport Capacity Design Teams

Airport Capacity Design Teams address capacity problems at airports with significant flight delays. The teams are composed of: FAA representatives from ASC, the Technical Center, Air Traffic, and the appropriate FAA Region; airport operators; airlines; general aviation; and other aviation industry representatives.

Airport Capacity Design Teams consider capacity improvement alternatives. Impacts of alternatives that are considered technically feasible are evaluated by computer simulation modeling (SIMMOD, RDSIM, ADSIM)conducted by the FAA Technical Center's Aviation Capacity Branch. The product of the study is a set of capacity-enhancing recommendations. Environmental, socioeconomic, and political implications, while not evaluated by the design teams, are addressed by the FAA and local authorities if and when the airport authority chooses to pursue one or more of the capacity enhancement alternatives.

The presence of a recommended improvement in a Capacity Enhancement Plan does not obligate the FAA to provide Facilities and Equipment (F&E) or AIP funds.

Recommendations from Previous Airport Capacity Studies

Since 1985, more than 40 Airport Capacity Design Team studies have been conducted. The typical Airport Capacity Design Team considers 20 to 30 alternatives for increasing capacity. Table 3-4 lists completed airport capacity studies and their recommendations according to generalized categories of im-

As environmental, financial, and other constraints continue to restrict the development of new airports in the United States, increased emphasis has been placed on the redevelopment and expansion of existing airport facilities.

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4. Electronic copies of many of these reports can be obtained from the ASC world wide web site: http://www.asc.faa.gov

Table 3-3.

Completed Airport Capacity, Tactical Initiative, and Regional Design Studies

Study	Date
Capacity Enhancement Plans	
Albuquerque Int'l	1993
Boston Logan Int'l	1992
Charlotte/Douglas Int'l	1991
Chicago Midway	1991
Chicago O'Hare Int'l	1991
Cleveland-Hopkins Int'l	1994
Dallas-Ft. Worth Int'l	1994
Detroit Metropolitan Wayne County	1988
Eastern Virginia Region	1994
Fort Lauderdale-Hollywood Int'l	1993
Greater Pittsburgh Int'l	1991
Hartsfield Atlanta Int'l	1987
Hartsfield Atlanta Int'l Update	1995
Honolulu Int'l	1992
Houston Intercontinental	1993
Indianapolis Int'l	1993
Kansas City Int'l	1990
Lambert St. Louis Int'l	1988
Las Vegas McCarran Int'l	1994
Los Angeles Int'l	1991
Memphis Int'l	1988
Memphis Int'l Update	1997
Miami Int'l	1989
Minneapolis-Saint Paul Int'l	1993
Nashville Int'l	1991
New Orleans Int'l	1992
Oakland Int'l	1987
Orlando Int'l	1990
Philadelphia Int'l	1991
Phoenix Sky Harbor Int'l	1989
Port Columbus Int'l	1993
Portland Int'l	1996
Raleigh-Durham Int'l	1991
Salt Lake City Int'l	1991
San Antonio Int'l	1992
San Francisco Int'l	1987
San Jose Int'l	1987
San Juan Luis Muñoz Marín Int'l	1991
Seattle-Tacoma Int'l	1991
Seattle-Tacoma Int'l Update	1995
Washington Dulles Int'l	1990
Tactical Initiatives	
Charlotte Douglas Int'l	1995
Los Angeles Int'l (Commuter Gates)	1996
Los Angeles Int'l (TBIT Expansion)	1993
New York La Guardia Airport	1994
Orlando Int'l	1995

Table 3-4.

Completed Airport Capacity Studies and Recommendations

√ Recommended

C Completed

⊗ No Longer Under Consideration

Airports / Recommended Improvements[1]	Airfield Improvements	Construct third parallel runway	Construct fourth parallel runway[2]	Relocate runway	Construct new taxiway	Runway extension	Taxiway extension	Angled exits/improved exits	Holding pads/improved staging areas	Terminal expansion	Facilities and Equipment Improvements	Install/upgrade ILSs	Install/upgrade RVRs	Install/upgrade lighting system	Install/upgrade VOR	Upgrade terminal approach radar	Install ASDE	Install PRM	New air traffic control tower	Wake vortex advisory system	Operational Improvements	Airspace restructure/analysis	Improve IFR approach procedures	Improve departure sequencing	Reduced separations between arrivals	Intersecting operations with wet runways	Expand TRACON/Establish TCA	Segregate traffic	De-peak airline schedules	Enhance reliever and GA airport system
Albuquerque					C	C	C	C	√	√		C			√								√		√					√
Atlanta (Update Study)			√					√	√	√		√						√		√					√				⊗	√
Boston					⊗	⊗	⊗	√	C			√								√			C			√				
Charlotte-Douglas						C	√	C	√			√		√			√	√								√	C			√
Chicago Midway					√	C			C	C													√		√					
Chicago O'Hare				√	⊗	√		C	C			C											√			C				
Cleveland		⊗		√	√	√	√	√		√		√			√			√					√	√	√					√
Dallas-Ft. Worth					C	√		C															C	C	C					C
Port Columbus		√	⊗	√	√	√		√	√	√		√		√			√	√	√			√	√		√				√	√
Fort Lauderdale					√	⊗		√	√	√		√			√	C		√		√		√	√		√				√	√
Honolulu		√				√		√	√	√		√																	√	C
Houston Intercontinental		√	√		√	√		√	√	√		√											√						√	√
Indianapolis		√	√	C	√			√	√			√	√	√			√						√		√					√
Kansas City		√	⊗				C	√	√	√		√	√				C						√		√				√	
Las Vegas					√	C	C		C	√		√											√			√				C
Los Angeles					C	√	C	√	C	√		C							C			√								
Memphis Update					√	√	√	√	√			√						√		√			C		√				√	√
Miami					C		√	C	C			C	C	C			C						C							C
Minneapolis-Saint Paul		√			√	√		√	√	√		√	√	√	√			√				√			√					√
Nashville			√	C	C	√	√		√			C								√		C	√				√		⊗	√
New Orleans					C										√				C			√	C		C					C
Newport News						√		√															√		√					
Norfolk						√						√	√	√											√					
Oakland					√			√	√																					
Orlando			√		√		C		√			√			√		√	√				C	√					√		√
Philadelphia		√		√		√												√				√	√	√						
Phoenix		√			√		C	√	C	C		C		√	C								√	√	√			√	√	C
Pittsburgh			√			C				√		C						√				√								
Portland					√		√	√				√											√	√	√			√		
Raleigh-Durham		√	⊗	⊗	√			√	√			√	√				√			√		√	√		√		√			
Richmond						√		√				√	√	√									√		√					
St. Louis		√					C	√	√			√		√			C			√			C		C				⊗	
Salt Lake City		C					C	C	√	√		C	C	C			C	√					C		C					√
San Antonio		√			√	√	√		C			C	C	√				√		√		√	√		√					√
San Fransisco		⊗	⊗			√	C	√	√															C					√	C
San Jose						C		C	C															C						
San Juan, Puerto Rico					√		√	√	√	√				√	√				C	√					√					√
Seattle-Tacoma		√						C				√								√			√		C				⊗	
Washington-Dulles		√			C	C	C		C	√			C	C									C		C				⊗	⊗

1. Recommendations summarized and grouped in generalized improvement categories.
2. Construct fifth parallel runway in the case of Atlanta.

provements. The table indicates those recommendations that have been implemented, completed, or are no longer under consideration.

Airfield improvements were recommended for all of the airports studied. Common airfield recommendations include building or extending runways and taxiways and improving exits and staging areas to increase the efficiency of existing runways. At least one of the recommended airfield improvements has been completed at 25 of the airports studied. Airfield improvements such as construction of new runways and runway extensions may take more than ten years from proposal to completion due to financing constraints and the need to study and address environmental concerns.

Common recommendations for improving F&E are the installation or upgrade of Instrument Landing Systems (ILS) to improve runway capacity during IFR operations and the installation of Runway Visual Range (RVR) and approach lighting systems. Improvements to F&E and operations are generally less expensive and time consuming to implement than airfield improvements. However, like airfield improvements, the ability to implement F&E recommendations is contingent upon available financing. F&E improvements such as the installation of RVRs and approach lights generally coincide with the completion of a new runway or runway extension.

Common procedural recommendations include improved IFR approach procedures and reduced separation standards for arrivals. Enhancement of the reliever and general aviation airport system is also a frequent recommendation for moderating the demand on a given airport. Improved IFR approach procedures and reduced separations between arrivals have been implemented at several of the airports studied by the Capacity Design Teams.

1997 Airport Capacity Design Team Studies

Airport Capacity Design Team studies, or updates of previous studies, in progress or completed in 1997, are summarized below.

Reno/Tahoe International Airport (RNO)

Reno has experienced steady and sustained growth over the last decade. As a result, passenger enplanements more than doubled from 1.4 million in 1983 to 2.9 million in 1995. Therefore, in February 1995 an Airport Capacity Design Team for RNO was formed. Capacity enhancing alternatives considered include the construction of a new apron, a new concourse, de-icing facilities, and runway and taxiway extensions. Possible F&E improvements include development of precision approaches and the installation of Doppler radar and RVR systems. Procedural improvements include adoption of land and hold short procedures (LAHSO), and a 2.5 nm in-trail separation. Publication of this study is scheduled for 1998.

Memphis International Airport Update (MEM)

Memphis International Airport is the 25th busiest airport in the country when ranked by 1996 aircraft operations. MEM has experienced steady, sustained growth over the past five years as operations increased 5.6 percent and enplanements increased more than 15 percent. MEM is ranked as the number one air cargo airport in the world for the fifth consecutive year. If improvements are not made, continued traffic growth will cause more than 20,000 hours of annual delay through 2006.

In 1995 ASC began an update to the 1988 Capacity Enhancement Plan. The update was initiated in light of the fact that a new runway was to be commissioned in December 1996, and soon after, an existing runway would be closed for reconstruction. The design team's primary goals were to provide input for the Memphis Master Plan update and use computer modeling to determine how to maximize use of the new operational third parallel runway, while existing runways are being reconstructed. The Memphis International Airport Capacity Enhancement Plan Update was completed during 1997 and the most significant recommendations include:

- Extend Runway 18C/36C to the south to 11,100 feet to accommodate non-stop long range flights;
- During reconstruction of Runway 18R/36L, operate Taxiway M as an air carrier runway with arrivals and departures in north and south flow during visual flight rules (VFR) only;
- Extend Taxiway N to the full length of existing Runway 18R/36L to provide improved access to Runway 36L and provide temporary service to Taxiway M while being used as an active runway.

Miami International Airport Update (MIA)

When ranked by aircraft operations, MIA is fifth on the list of the 100 busiest airports in the U.S. In the past five years, MIA experienced a 28 percent increase in passenger enplanements and a 12.4 percent increase in operations. MIA will continue to experience more than 20,000 hours of annual delay through the year 2006 if no capacity improvements are made. The update to the 1989 Capacity Enhancement Plan for MIA was initiated in

September 1995 in response to traffic growth and the need to further analyze capacity enhancement alternatives. The capacity design team reassessed some previously recommended improvements and considered potential new improvements to increase MIA's capacity. The team analyzed a new, closely-spaced parallel runway and a reconfigured terminal and conducted an airfield study. The MIA study is scheduled for publication in 1998.

Newark International Airport (EWR)

A study of Newark began in November 1996. The Design Team is investigating the effect of a runway extension that will intersect the crosswind runway and other short term improvements such as approaches to other airports using EWR's Differential Global Positioning System (DGPS). The team is also studying innovative approach procedures to the converging runway and innovative dual approach procedures to the closely spaced parallel runways. The EWR study will be published in FY98.

1997 Tactical Initiative Teams

Tactical Initiative Teams focus on providing immediate relief to airports with chronic delay. The recommendations of Tactical Initiative Teams generally focus on procedural changes that can be implemented quickly with little financial investment. Ongoing Tactical Initiative projects in 1997 are summarized below.

San Diego International Airport (SAN)

The San Diego study began in May 1996; the expected completion date is late 1998. The Tactical Initiative Team has been investigating the effect of another terminal, ground flow and other short term improvements such as an additional terminal concourse, taxiway development, and remote aircraft parking areas already approved in the Immediate Action Plan. The study analyzes major airfield improvement concepts developed in the 1997 airport Master Plan study.

Las Vegas McCarran International Airport (LAS)

LAS is adding another gate complex, Terminal D, to the airport. Construction on this terminal is underway. The FAA is examining the impacts of an initial increase in traffic on existing taxiways and gates. In addition, the ability of the new terminal complex to accommodate future traffic levels will be tested. Other issues such as off-gate and overnight parking will also be examined. This new study is an extension of the previous Las Vegas study completed in 1994. The expected completion date is February 1998.

1997 Regional Capacity Design Teams

Looking beyond the individual airport and its immediate airspace, the Office of System Capacity plans regional studies. Regional Capacity Design Teams analyze all the major airports in a metropolitan or regional system and model them in the same terminal airspace environment. This regional perspective explores how capacity-producing improvements at one airport will affect air traffic operations at other airports and within associated airspace.

Northeast Region Capacity Design Study

The Northeast Region study, which began in September 1996, was initiated to analyze the impacts of the decentralization of northeastern airports as passengers migrate from the primary airports (BOS, EWR, JFK, and LGA) for each metropolitan area. The Design Team is working with the Volpe National Transportation Systems Center to study the effect of increased passenger traffic at the outlying airports in both the New York and Boston areas.

Anchorage Area Airspace Design Team Study

The Anchorage Area Airspace Design Team Study will identify ways to best accommodate existing and future aircraft operations in the Anchorage area. The study is expected to last 18 months and involves four major airports: Anchorage International (ANC), Lake Hood, Merrill Field, and Elmendorf. Additionally, the private use airports and heliports in the Anchorage area will be included in the study.

The study's complexity is heightened by multiple airport interaction and the strong presence of GA aircraft in Alaska and the Anchorage area — Lake Hood is the busiest seaplane facility in the world, and Merrill Field is one of the busiest GA airports in the world. Obtaining representative data on those GA users who do not use air traffic control services adds an additional degree of complexity to this study.

As the scope of the study is being defined, the following considerations are being evaluated: the impact on operations in the Anchorage area of constructing a new runway and runway extension; innovative approach procedures to the converging runway at ANC and to the closely spaced parallel runways; and means of addressing congestion problems caused by more than one million annual operations transiting over Point McKenzie, a single fix.

CHAPTER 4: AIRSPACE DEVELOPMENT

Airspace development studies strive to relieve congestion and reduce system delay by determining how to: restructure airspace; reroute traffic; or modify arrival, departure, or en route and terminal flow patterns. En route airspace studies may extend to one or more Air Route Traffic Control Centers (ARTCCs), encompassing traffic flowing into and out of several airports. In contrast, terminal airspace studies address only the terminal area, usually encompassing about a 40 mile radius around the airport.

En route airspace studies may be prompted by experienced or projected congestion and delays, airport development, improved operational procedures, or resectorization of the airspace that provides opportunities to modify traffic flow. From the analysis stage to implementation, major redesign of en route airspace is a complex process that may take up to ten years. En route airspace capacity studies are conducted jointly by the Office of System Capacity (ASC), Air Traffic (AAT), and the Office of Environment and Energy (AEE).

Terminal airspace studies, generally intended to follow Airport Capacity Design Team studies, examine ways to ensure that the airport's airspace can most efficiently accommodate new traffic patterns resulting from new runways and runway extensions and projected traffic increases. Terminal airspace studies are typically conducted by the Airport Capacity Design Team that conducted the airport capacity enhancement study, with the assistance of the FAA Technical Center and additional Air Traffic representatives. Table 4-1 lists completed en route and terminal airspace studies.

Table 4-2 lists the various alternatives proposed for improving traffic flow for each airspace region. Common airspace improvement alternatives include: relocating arrival fixes, creating new arrival and departure routes, modifying ARTCC traffic flows, and redefining Terminal Radar Approach Control (TRACON) boundaries.

This chapter describes ongoing and recently completed en route and terminal airspace studies. It concludes with a short description of the FAA's involvement in a relatively new airspace frontier, commercial space.

Table 4-1.

Completed En Route and Terminal Airspace Studies

Terminal Airspace
Houston Intercontinental
Minneapolis-St. Paul Int'l
San Bernardino/Ontario

En Route Airspace
Chicago
Dallas-Ft. Worth
Denver
Expanded East Coast Plan
Houston-Austin
Kansas City
Los Angeles
Oakland
New York
Jacksonville
Atlanta
Miami

Table 4-2.

Airspace Design Alternatives by Airspace Region

Studied Alternatives / Airspace Regions	Chicago	Dallas-Ft. Worth	Denver	Expanded East Coast Plan	Houston-Austin	Kansas City	Los Angeles	Oakland	New York	Jacksonville	Atlanta	Miami
Relocating arrival fixes	√	√				√					√	
New arrival routes		√	√	√	√	√		√	√	√	√	√
New departure routes	√		√	√	√	√	√	√	√	√	√	√
Modifications to ARTCC traffic		√		√	√	√	√	√	√	√	√	
New airport			√		√							
Hub/non-hub alternatives					√							
Change in metering restrictions	√			√				√				√
Redifining TRACON boundaries		√		√	√		√	√			√	
Redifining sector ceilngs									√	√	√	
Resectorization									√	√	√	√
Military traffic considered		√			√		√	√				
New runways at existing airports	√	√				√						
Specific modeling of 2 or more airports for interactions analysis	√	√				√			√	√	√	√

Ongoing Airspace Studies

ASC is currently involved in en route airspace studies in three regions of the country: Chicago; the west coast, including northern California, southern California and Las Vegas; and Salt Lake City. ASC is also conducting a terminal airspace study at Phoenix International Airport.

Chicago Metroplex Airspace Analysis

The purpose of this project is to increase the efficiency of existing airport capacity by redesigning arrival and departure routes and using a new TRACON with an updated area route terminal system (ARTS) to improve airspace traffic flow. The study area consists of the Chicago Center, which includes traffic operations within Chicago and Milwaukee TRACONs, and en route portions of the four adjacent ARTCCs.

The FAA identified the time and location of traffic bottlenecks and other constrained operations by animating traffic flows, computing traffic count statistics, and computing time and distance relationships. Figure 4-1 illustrates the arrival paths for Chicago O'Hare International Airport (ORD). Wavering flight paths indicate that flights were path-stretched by air traffic controllers to regulate traffic flow approaching the terminal area.

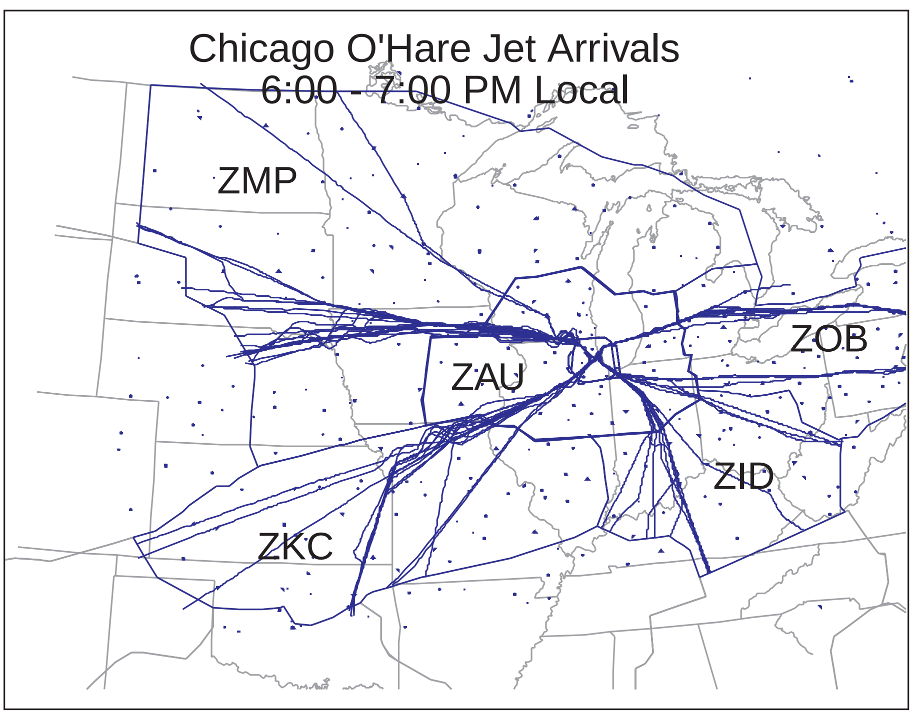


Figure 4-1.

Flight Paths Over Five-Center Area

After extensive analysis, three airspace design alternatives were developed that would provide an airspace structure to increase airspace capacity for O'Hare International arrivals. The first alternative is to add four arrival routes to Chicago's TRACON for ORD arrivals. During heavy traffic periods, two additional dual routes (Alternative 1A) or one dual route (Alternative 1B) could be activated as required. The second alternative is to rotate the existing four corner posts by 45 degrees, allowing redistribution of traffic flow and an additional arrival fix from east and west. The third alternative is to establish two additional arrival corner posts (totaling six) for ORD arrivals. Figure 4-2 is a simplified diagram illustrating the basic routing concepts behind the proposed alternatives. For each alternative, the projected annualized dollar savings resulting from the reduced flight time at the baseline traffic level is presented.[1] The FAA is currently conducting analyses of the likely environmental impacts.

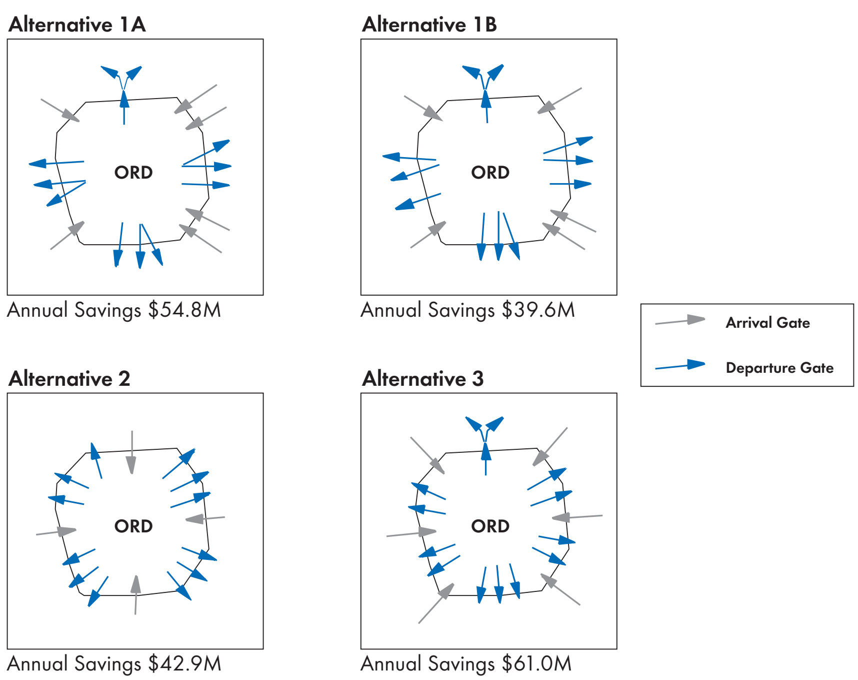


Figure 4-2.

Airspace Design Alternatives for Chicago

1. All aircraft operating costs savings quoted in this chapter are based on marginal aircraft operating cost of $1,600 per hour.

West Coast Airspace Analysis

ASC is involved in a large-scale analysis of the airspace on the west coast of the United States, ranging from San Francisco/ Oakland in the north, to Los Angeles in the south, and extending to Las Vegas to the east.

In California, the airspace of two major new facilities, the Southern California TRACON (SCT) and the Northern California TRACON (NCT), are being analyzed to capitalize on potential efficiency and capacity gains made possible by the new facilities. The SCT controls terminal airspace in the Los Angeles-San Diego area and consolidates the operations of the former Los Angeles, Coast, Burbank, Ontario, and San Diego TRACONs into a single facility. The NCT (which has been proposed but not yet constructed) will control airspace in San Francisco, Sacramento, and their surrounding areas. The consolidation and expansion of the airspace surrounding San Francisco into the NCT will enhance controller flexibility for merging and sequencing aircraft to and from northern California. The FAA has developed proposals for streamlining the coastwise traffic flow while addressing the long-haul traffic problems specific to each facility.

SCT Airspace Analysis

Over the last year, the FAA developed airspace alternatives to address traffic movement problems within the Los Angeles Basin area. An Arrival Enhancement Procedure (AEP) for Los Angeles International Airport (LAX) would provide dual arrival streams for flights landing at LAX from the east. Figures 4-3 and 4-4 show a comparison of flight tracks for the existing landing procedure and the proposed traffic flows under the AEP alternative, respectively. Currently, traffic from the east and northeast merge into a single flow over CIVET for sequencing to Runway 25L at LAX. Under the AEP, the path for flights arriving from the northeast would remain unchanged. Flights arriving from the east would be rerouted to GEORG, REBCA, PDZ, and ARNES, then to Runway 25L. The new arrival route would remove pressure on CIVET and reduce congestion related delays. Annualized cost savings due to reduced flight times as a result of the AEP are projected to be $13.3 million at baseline traffic levels. By 2005, savings are expected to increase to $64.9 million annually.

NCT Airspace Analysis

Two FAA proposals for enhancing airspace efficiency in northern California are: an offshore standard terminal arrival route (STAR) for Oakland Airport (OAK), to remove Oakland-bound

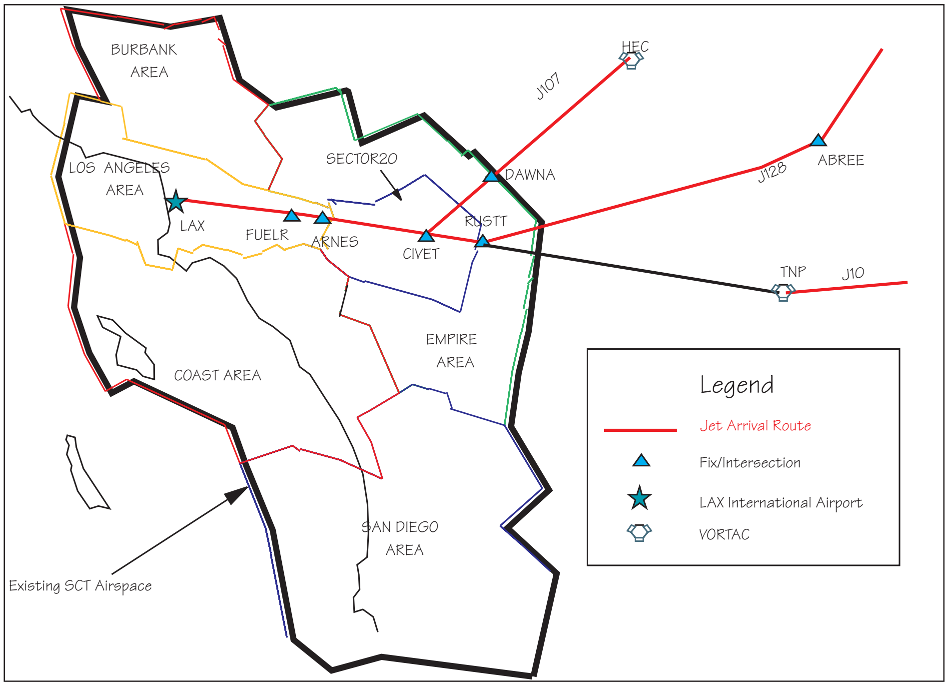


Figure 4-3.

Existing Routes to Los Angeles International Airport

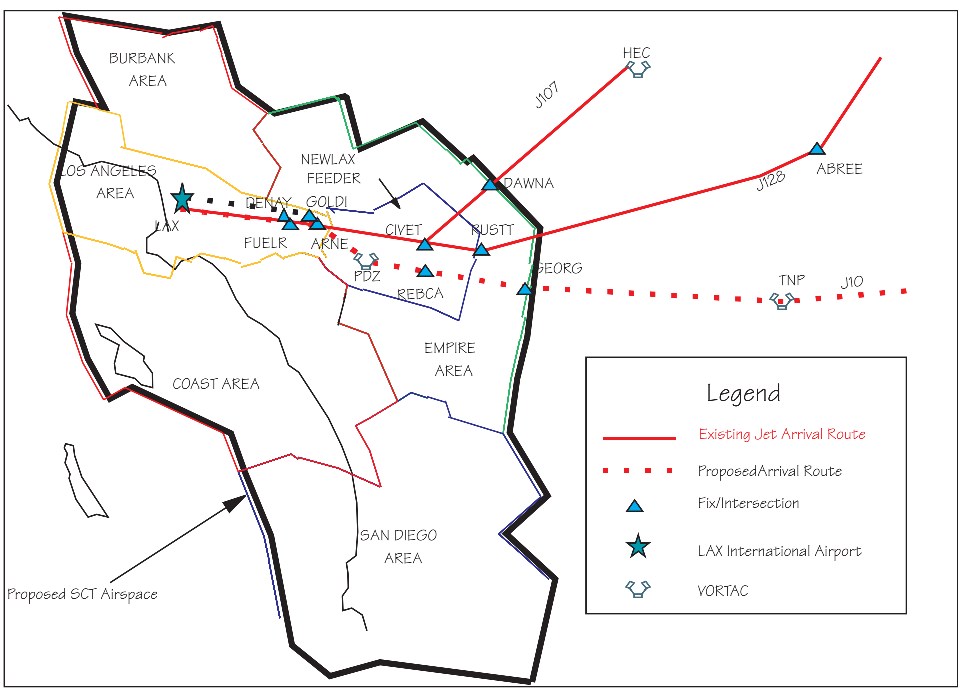


Figure 4-4.

Proposed Arrival Enhancement Procedure (AEP) to Los Angeles International Airport

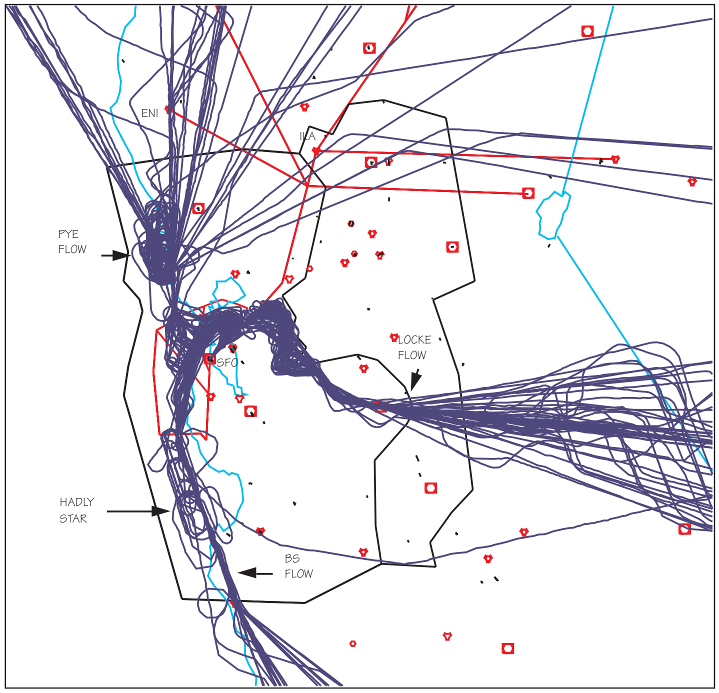


Figure 4-5.

Flight Tracks of SFO Arrivals

traffic from the San Francisco arrival stream; and a straight-in STAR for northwest arrivals to San Francisco International Airport (SFO).

Figure 4-5 illustrates the flight paths of aircraft arriving to SFO over a six-hour period. The distended and circular flight paths for northbound flights approaching SFO and OAK are evidence of spacing techniques used by air traffic controllers to moderate traffic in the terminal areas. To reduce congestion in the northbound traffic, the FAA is considering segregating northbound SFO and OAK traffic by establishing an offshore STAR for flights bound for OAK.

Currently, most air traffic from the north, northwest, and northeast is routed over PYE (an arrival fix at Point Reyes) on approach to SFO. Due to congestion, traffic over PYE frequently must be path-stretched for sequencing into SFO. The FAA is studying the development of a new, straight-in STAR for SFO arrivals over UPEND, an initial approach fix for runway 19L. Implementation of the straight-in STAR is dependent on the consolidation and expansion of the airspace surrounding SFO into the NCT to enhance controller flexibility for merging and sequencing of aircraft. The new STAR would reduce average route distance for SFO arrivals by nearly 40 miles. Annual aircraft operating cost savings resulting from the SFO straight-in and OAK offshore STARs are estimated at $6.6 million at baseline traffic levels.

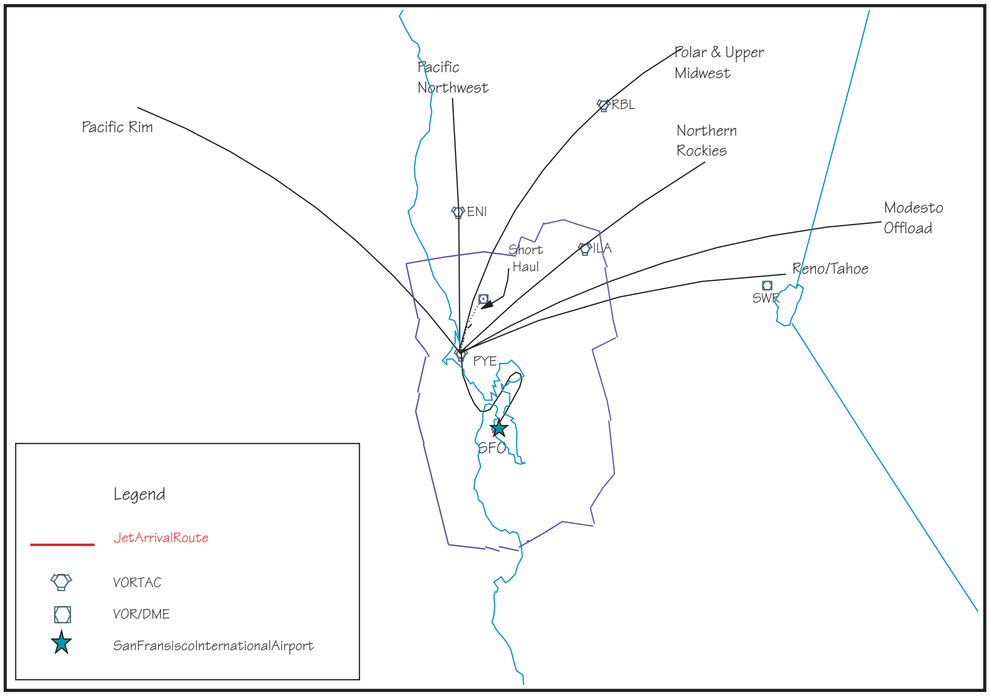


Figure 4-6.

Region of Origin and Existing Routings for SFO Arrivals

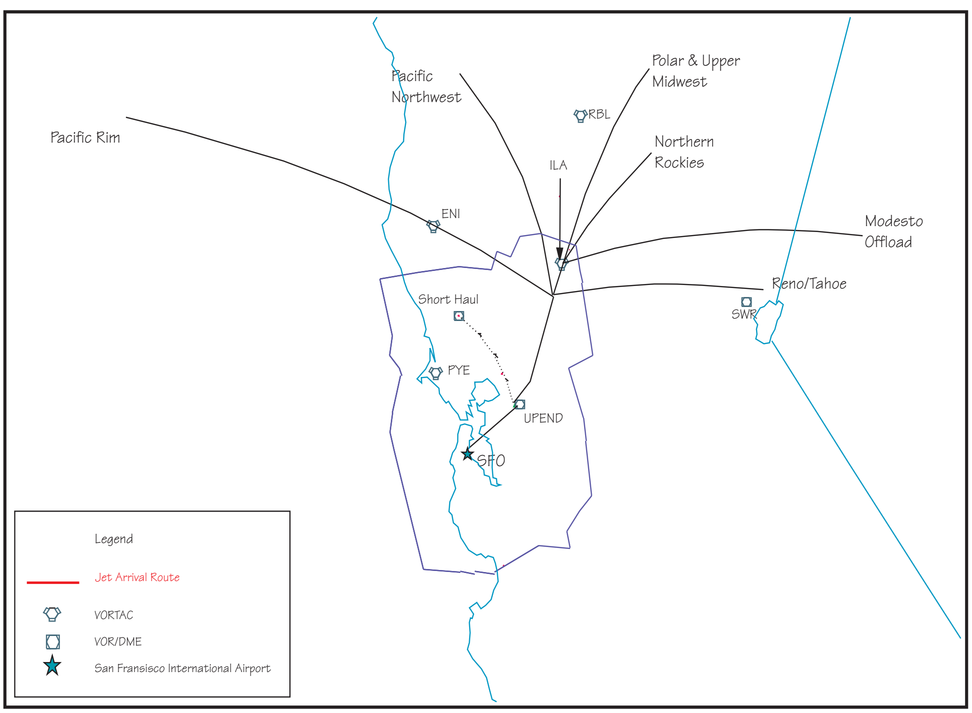


Figure 4-7.

Region of Origin and Routings for Proposed Straight-In star for SFO Arrivals

Figures 4-6 and 4-7 show a comparison of existing routings of SFO arrivals over PYE and the proposed rerouting of aircraft over UPEND under the straight-in STAR, respectively.

Las Vegas Airspace Analysis

In 1995, Las Vegas had 29 million tourists. Of these, over 14 million traveled by air. By 1997, the number of tourists increased to more than 34 million, with more expected as new hotel rooms continue to be built. The consistent increase in visitors to Las Vegas has strained the operations at McCarren International Airport (LAS), which experienced more than 20,000 hours of delay in 1996, and for which continued delays are projected if no capacity improvements are made. Currently, LAS is constructing an additional 60 gates, which will more than double the number of existing gates. Although one runway is being upgraded, this improvement will probably not be sufficient to accommodate projected demand. To relieve pressure on LAS, most VFR sightseeing tour operations have been moved to North Las Vegas Airport (NLV).

The Las Vegas airspace analysis encompasses the airspace of the Los Angeles Center, including LAS and NLV. Computer analysis was used to design alternative arrival and departure routings in conjunction with modified runway use to enable the FAA to better service the dramatic growth in air traffic demand in the Las Vegas area. The study also assesses how best to route tour flights so that they are compatible with other flights within the Las Vegas TRACON and how moving tour operations to NLV has affected operations at LAS.

A proposed corner post structure for LAS arrivals and the establishment of dedicated arrival and departure runways could result in substantial flight-time savings. The proposed airspace changes would result in daily flight-time savings of 65 hours at current traffic levels; aircraft delays of greater than 15 minutes would be reduced by 82 percent. At anticipated traffic levels, projected delay savings are even more pronounced.

Salt Lake City Airspace Analysis

Air traffic activity at the Salt Lake City Airport (SLC) has increased significantly in the past few years, from 317,000 operations in 1992 to 374,000 operations in 1996. SLC is a hub for Delta and SkyWest Airlines. Federal Express is in the process of building a cargo hub operation there. SLC experienced more than 20,000 hours of delay in FY96, and if no further capacity enhancements are made, will continue to exceed 20,000 hours of delay annually (see Table 1-5). The Salt Lake City airspace analysis began in April 1997. The purpose of the study is to reduce traffic flow complexity to accommodate expected traffic growth, including traffic growth projections for the upcoming 2002 Winter Olympic games. Routing options for SLC are limited by the presence of military special use airspace to the west of the airport, and mountainous terrain to the east.

Airspace analysis and modeling tools were used to create graphic displays of existing flight tracks to assess current airspace operations within Salt Lake Center and portions of Denver Center. Under the existing air traffic structure, certain sectors handle both arrivals and departures, which is not ideal from a workload and safety standpoint. Figure 4-8 shows the current arrival tracks and departure routes for SLC. The FAA developed an improved corner post structure for arrivals in conjunction with additional downwind legs for the purpose of increasing runway throughput, and redefined sector boundaries. Figure 4-9 shows the proposed resectorization and arrival and departure structure. Restructuring of the en route airspace will allow refinements of air traffic control in the terminal airspace, thus generating additional capacity gains.

Phoenix Terminal Airspace Analysis

Due to a significant increase in operations, a Terminal Airspace Study has been initiated in Phoenix. The study, which also involves the Albuquerque Center, began in the fall of 1997. This team is addressing the expected increase of arrival and departures in the Phoenix area.

Commercial Space Transportation

The FAA regulates the U.S. commercial space transportation industry, licenses commercial launches and launch sites, and manages the airspace required for commercial launches to assure safety. Most commercial space launches contain communications, scientific, weather, or remote sensing satellites. Launches are financed by private corporations, states, Air Force grants, and NASA. Unlike airports, where the FAA builds and maintains air traffic control facilities, the FAA has no infrastructure at launch sites.

As of November 1997, there have been 81 licensed launches; all but one have launched from one of the following Federal sites: Cape Canaveral, White Sands Missile Range, Vandenberg, Wallops Island, and Barking Sands, Hawaii.

In September 1996, the FAA issued the first non-Federal space launch site license to the California Spaceport. In May 1997, the FAA issued a license to the Space Florida Authority. The FAA is

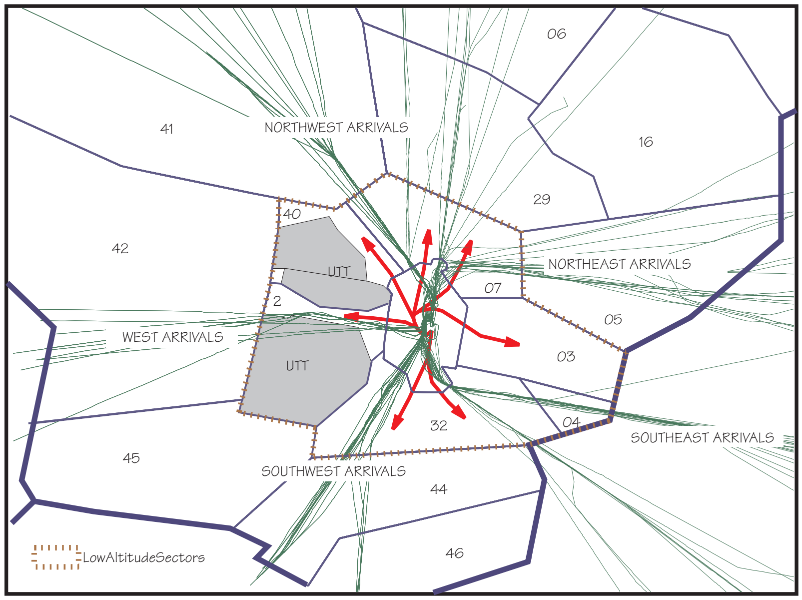


Figure 4-8.

Current Arrival Tracks and Departure Routes for SLC

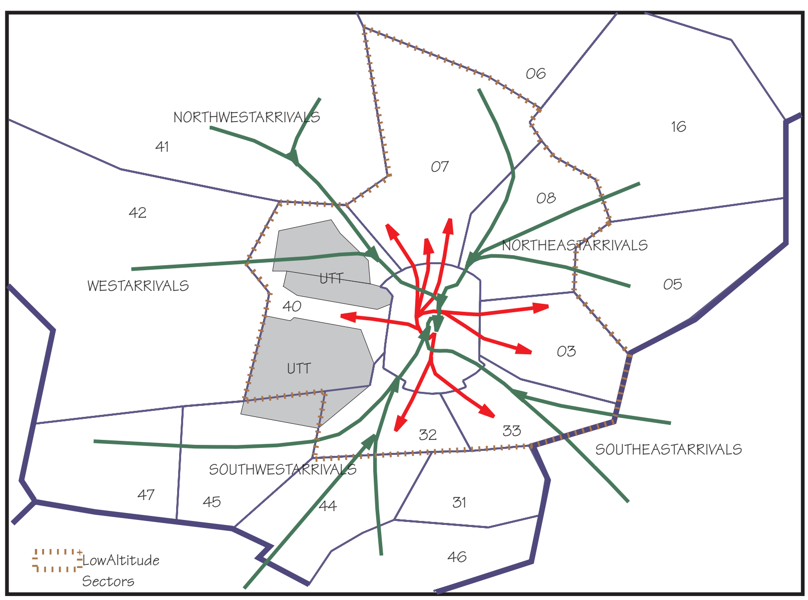


Figure 4-9.

Proposed Arrival and Departure Routes for SLC also working with Alaska, Nevada, New Mexico, and Virginia on other proposed commercial launch sites. The FAA is preparing regulations for licensing commercial launches and launch sites.

The FAA Office of Commercial Space Transportation is currently leading a program to analyze airspace requirements for launch and reentry of space vehicles. This project, which began in early 1977, will focus on the current practice of using SUA and refining the amount of airspace required during a launch or reentry. The first part of the study includes an analysis of the SUA required for the space shuttle.

CHAPTER 5: NEW OPERATIONAL PROCEDURES

This chapter describes new and developing air traffic control procedures requiring minimal or no investment in new technology. Many of these developments are free flight initiatives that will give pilots more flexibility in determining their routes, altitude, speed, and departure and landing times. Modernization of the National Airspace System (NAS) equipment over the next decade will provide additional opportunities to develop procedures that take advantage of new technological capabilities. The procedures described in this chapter are listed below.

En Route Procedures

- Direct routing
  - Area Navigation (RNAV)
  - Continue expansion of the National Route Program (NRP)
  - Reduce the number of Air Traffic Control (ATC)-Preferred Routes
  - Improved civilian access to Special Use Airspace (SUA)
- New guidelines for imposing restrictions

Oceanic En Route Procedures

- Reduced Vertical Separation Minima (RVSM)
- Reduced Horizontal Separation Minima (RHSM)
- In-Trail Climb and In-Trail Descent
- Dynamic Aircraft Route Planning (DARP)

Terminal Area/Approach Procedures

- RNAV approaches
- Simultaneous converging instrument approaches
- Removal of 250 knot speed limit below 10,000 feet in Class B airspace

En Route Procedures

New en route procedures give airspace users more flexibility to determine their routes, altitude, and speed.

Direct Routing

The ability of pilots to plan and fly direct routes is being improved through several procedural initiatives.

Area Navigation (RNAV)

Most aircraft today have equipment that enables them to fly direct routes using a procedure known as RNAV. RNAV is a generic term that refers to any instrument navigation performed outside of conventional routes — routes defined by the ground-based navigational aids or by intersections formed by two navigational aids. Technologies such as Flight Management Systems (FMS), LORAN-C, and inertial guidance systems have offered RNAV capability to aircraft, especially commercial carriers, for nearly two decades. With the introduction and widespread acceptance of Global Positioning System (GPS) to civilian aviation in the 1990s, even more aircraft have acquired this capability.

To make greater use of RNAV capabilities in terminal airspace, the FAA has begun to develop RNAV arrival and departure procedures for the top 50 airports.

While RNAV offers the potential for more flexibility and greater airspace efficiency, its use is often restricted by air traffic control procedures that are based on established route structures. This is the case in high-density terminal airspace where air traffic controllers rely on the use of standard instrument departures (SIDs) and standard terminal arrival routes (STARs) to align and sequence traffic. While possible, it is difficult for controllers to simultaneously accommodate non-standard RNAV arrival and departure procedures with SIDs and STARs. For this reason, RNAV arrival and departure routes are typically restricted to periods of low traffic.

To make greater use of RNAV capabilities in terminal airspace, the FAA has begun to develop RNAV arrival and departure procedures for the top 50 airports. For major airports within 500 nm of each other (e.g., Phoenix and Las Vegas), the FAA is exploring the concept of city pair SID/STAR routes whereby the STAR would begin where the SID ends, and en route air traffic control services would not be required. To accommodate longer range en route RNAV flights, the FAA has modified software to allow the filing of RNAV routes. Some RNAV routes have already been implemented in the Caribbean.

The National Route Program (NRP)

The NRP gives airlines and pilots increased flexibility in choosing their routes. NRP flights are not limited to published ATC-preferred routes; they are only subject to route limitations within a 200 nm radius of take-off or landing. This flexibility allows airlines to plan and fly the most cost-effective routes and increases the overall capacity and efficiency of the aviation system.

From January 1995 to November 1996, the NRP was expanded in ten phases, with each phase lowering the base altitude for participation. NRP operations are currently authorized at or above FL290 across the contiguous United States. Participation has increased with the implementation of each phase. In October 1995, there were 600 NRP flights daily. By September 1997, the average had increased to more than 1,500 NRP flights daily. Participation rates are higher on longer flights. The FAA estimates that the NRP saved the aviation industry as much as $65 million in 1997, or about $150 per flight, by allowing pilots to fly more optimal routes.

In an effort to expand the NRP and increase participation rates, the FAA is planning to eliminate the 200 nm requirement through the use of SID/STAR routes as ingress/egress points to the NRP. In doing this, the user will be allowed to file a SID to join an NRP route and to exit an NRP route via a STAR. Twenty-four SIDs and 15 STARs in six airport areas (Kansas City, St. Louis, Denver, Minneapolis, Salt Lake City, and Philadelphia) will be included in initial implementation. The first implementation of SID/NRP/STAR procedures is scheduled for early 1998. Future efforts to augment the NRP will focus on expansion of the NRP to altitudes below FL290.

Elimination of Unnecessary ATC-Preferred Routes

The FAA is striving to increase user routing flexibility by eliminating ATC-preferred routes where possible. ATC-preferred routes are important tools that help air traffic controllers organize traffic flows around major airports. There are currently 1,975 ATC-preferred routes. It is estimated that during a given day, pilots using the low altitude system (below 18,000 feet) add approximately 125,000 miles of extra distance to their flight plans as a result of published ATC-preferred routes. While it may never be desirable to eliminate all ATC-preferred routes, a recent audit indicates that at least 100-150 of these routes could be eliminated without negatively impacting system operations. In early 1998, the FAA plans to begin a six-month test phase in which these 100-150 ATC-preferred routes will be suspended. If no problems arise from the suspension of a particular ATC-preferred route, that ATC-preferred route will be eliminated. An additional 1,300 routes will be analyzed to assess whether they also can be eliminated. As additional candidates for elimination are identified, they will be added to the list of suspended routes, and undergo a six-month test phase before being eliminated.

Improving Civilian Access to Special Use Airspace (SUA)

The FAA is working with the Department of Defense (DOD) and NAS users to develop procedures for allowing greater civilian access to SUA.

Commercial and general aviation (GA) users seek access to Special Use Airspace (SUA) when that airspace is not in use by the military. The FAA is working with the Department of Defense (DOD) and NAS users to develop procedures for allowing greater civilian access to SUA. For these procedures to be effective, more real-time information on SUA availability is needed. Providing civilian users with this information requires the development of software for recording SUA time and altitude availability, as well as procedures and software for ensuring that users have access to the data. An operational trial conducted within the Edwards R-2508 airspace complex demonstrated that improved information exchange on the status of SUA can increase civil aircraft use of these military areas. During the operational trial, one airline saved approximately $180 per flight due to direct routing through the SUA, a monthly savings of $30,000. Due to the successful operational trial, the FAA has continued to disseminate SUA information on a real-time basis and allow flights to file flight plans that transverse the Edwards R-2508 airspace complex when it is not in use by the military. Figure 5-1 illustrates areas designated as SUA in the continental United States.

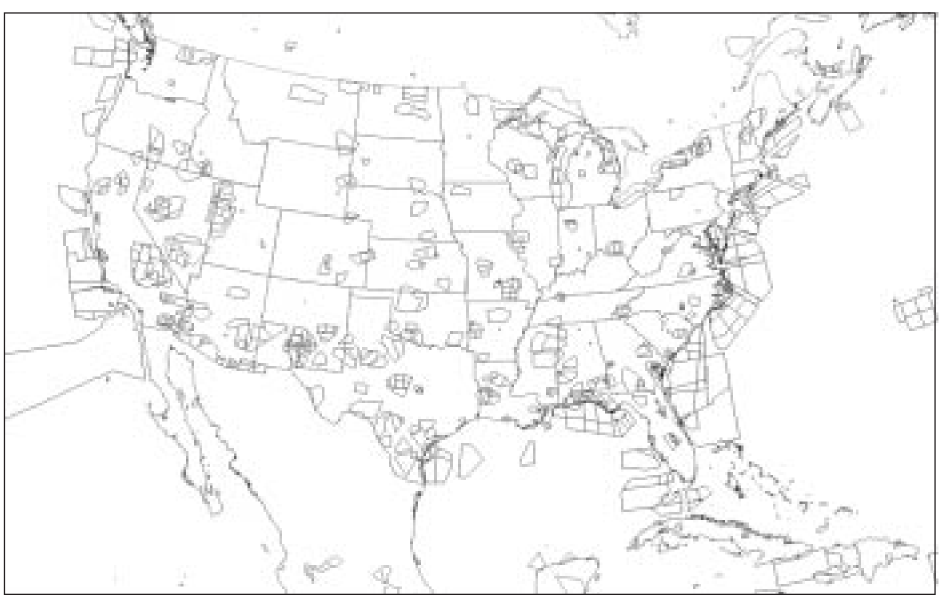


Figure 5-1.

SUA in the Continental United States

Information sharing between the military and the FAA on SUA availability has also increased capacity in other areas. For example, Southern California Terminal Radar Approach Control (TRACON) has developed a departure through an SUA that reduces delays from Los Angeles; High Desert TRACON receives immediate notification when a nearby SUA is available and forwards this information to the users. The FAA's Alaskan Region has worked with the military to provide frequencies and a 1-800 telephone number for pilots to obtain current information on SUA availability. Additional initiatives to increase access to SUA include cooperative decision-making between the DOD and the FAA on which hours SUAs will be active and redefining the boundaries of some SUAs.

Additional initiatives to increase access to SUA include cooperative decision-making between the DOD and the FAA on which hours SUAs will be active and redefining the boundaries of some SUAs.

New Guidelines for Imposing Restrictions

The use of air traffic restrictions is a tool by which air traffic controllers manage their workload, avoid congestion, and restrict aircraft movement during periods of severe weather. For example, during high volume arrival and departure periods, air traffic controllers may request that arriving aircraft maintain ten miles-in trail separation from the preceding aircraft to moderate traffic flow into the terminal area. Beginning in 1994, the FAA conducted several audits to measure the number and duration of restrictions and identify unnecessary restrictions. The initial audit showed 3,998 restrictions in effect for 8,229 hours. An audit performed one year later found a 28 percent reduction in the number of restrictions and a 34 percent reduction in the number of hours in which restrictions were in place. An audit in February 1996 yielded an additional 5 percent reduction in the number of restrictions and an additional 25 percent reduction in the number of hours in which restrictions were in place.

In June 1997, the FAA developed a procedure to prevent unnecessary traffic restrictions. In the past, facilities often imposed restrictions based on their recollections of prior traffic patterns. Under the new procedure, all requests for restrictions must be coordinated through the Air Traffic Control System Command Center (ATCSCC). Local facilities must do thorough testing and analysis of all options before calling ATCSCC with a request for a restriction. The ATCSCC will then analyze the options from a national perspective before discussing which option to implement. The decision to impose the restriction requires consensus between ATCSCC and the requesting facility. The result of the more stringent standard has been a further reduction in the number of restrictions, resulting in more efficient operations for the users.

Oceanic En Route Procedures

A number of procedural initiatives are currently underway that will increase capacity in the oceanic airspace while maintaining or improving safety.

Reduced Vertical Separation Minima (RVSM)

The goal of RVSM is to reduce the vertical separation between FL290 and FL410 from the current 2,000-feet minimum to 1,000-feet minimum.

Procedures implemented more than 40 years ago required a 1,000-feet minimum vertical separation between IFR aircraft below FL290 and 2,000-feet separation above FL290. The adoption of 2,000-feet separation above FL290 reflected the belief that altimeters in use at that time were less accurate at higher altitudes. Today, most aircraft are equipped with highly accurate altimeters. In response to the demand for more capacity, the FAA has begun a phased implementation of RVSM in the North Atlantic. The goal of RVSM is to reduce the vertical separation between FL290 and FL410 from the current 2,000-feet minimum to 1,000-feet minimum. Operational trials of RVSM began in the North Atlantic airspace from FL330 to FL370, inclusive, in March 1997. Expansion of the RVSM to FL310 and FL390 is planned for April 1998. Additional phases will lead to full implementation that will include FL290 and FL410. Implementation of RVSM should result in almost doubling available oceanic tracks across the North Atlantic within the relevant altitudes. Existing capacity constraints on optimum tracks and levels will be substantially reduced, and aircraft will be able to operate closer to optimum levels. Fuel savings from aircraft flying more optimum routes due to RVSM in the North Atlantic are projected to range from 13 to 18 million gallons annually, depending on traffic density. Based on the successful implementation of RVSM in the North Atlantic, users have requested RVSM in the Pacific as well. The FAA is now examining the feasibility of this initiative.

Reduced Horizontal Separation Minima (RHSM)

The current oceanic ATC system uses filed flight plans and position reports to track an aircraft's progress and ensure separation is maintained. The progress of an aircraft is monitored by ATC using position reports sent by the aircraft over high frequency (HF) radio. Position reports are infrequent (approximately one report per hour), and the accuracy of these reports depends on the accuracy of the on-board navigation system and timing standard aboard the aircraft. HF communication is subject to interference, disruption, and delay because it involves the use of radio operators to relay messages between pilots and controllers. These deficiencies in communications and surveillance have necessitated large horizontal separation minima.

As a result of improved navigational capabilities made possible by technologies such as GPS, TCAS, and controller to pilot data link communications (CPDLC), oceanic minimum horizontal separation standards, lateral and longitudinal, will be reduced. In the Pacific, lateral separation standards will be reduced from the current standards (60 nm to 100 nm depending on location) to 50 nm in specific oceanic areas in 1998. Where traffic density permits, longitudinal separation in the Pacific will be reduced from the current time-based standard of 15 minutes to 50 nm by late 1998. The reduced lateral separation minima will allow increased capacity during peak hours. The reduced longitudinal minima will provide increased opportunities for altitude changes to achieve optimum altitudes, thus saving fuel.

In-Trail Climb (ITC) and In-Trail Descent (ITD)

The ITC and ITD procedures enable a trailing aircraft in a non-radar (oceanic) environment to climb or descend through the altitude of a leading aircraft to a more desirable cruising altitude. Using the ITC or ITD procedure, an aircraft flying behind and 2,000 feet above or below an aircraft along the same oceanic route may request to climb or descend through the altitude of the lead aircraft as long as the distance between them is at least 15 nm and the ground speed closure rate is 20 knots or less. The pilot wanting to ascend or descend uses the Traffic Alert and Collision Avoidance System (TCAS) traffic display (described in Chapter 6) to positively identify and determine the distance to the lead aircraft. The trailing aircraft initiates the procedure, coordinates with the lead aircraft, and obtains climb or descent clearance from ATC. ATC maintains responsibility for separation during the maneuver. Standard non-radar spacing criteria are applied by ATC after the procedure is completed. ITC and ITD are the first procedures to utilize the display of traffic information on the flight deck to assist air traffic controllers in monitoring and reducing aircraft spacing requirements. The ITC and ITD procedures reduce the typical non-radar in-trail distance necessary to approve a climb or descent from 10 minutes (approximately 100 nm) to a minimum of 15 nm. Without the benefit of this procedure the trailing aircraft may be trapped below the lead aircraft. The inability to gain a higher altitude significantly increases fuel burn.

Operational trials for the ITC procedure have been conducted in the Oakland and Anchorage Flight Information Regions (FIRs) since 1994 with United Airlines and Delta Air Lines. Data collected during the trials indicate that pilots and controllers find the procedure useful and are using it correctly, safely, and cooperatively. Both pilots and controllers have recommended adoption of this procedure. Based on these data, the next phase of operational trials will include six additional airlines—American, Air New Zealand, Canadian, Cathay Pacific, Hawaiian, and Singapore airlines. Figure 5-2 illustrates the ITC and ITD procedures.

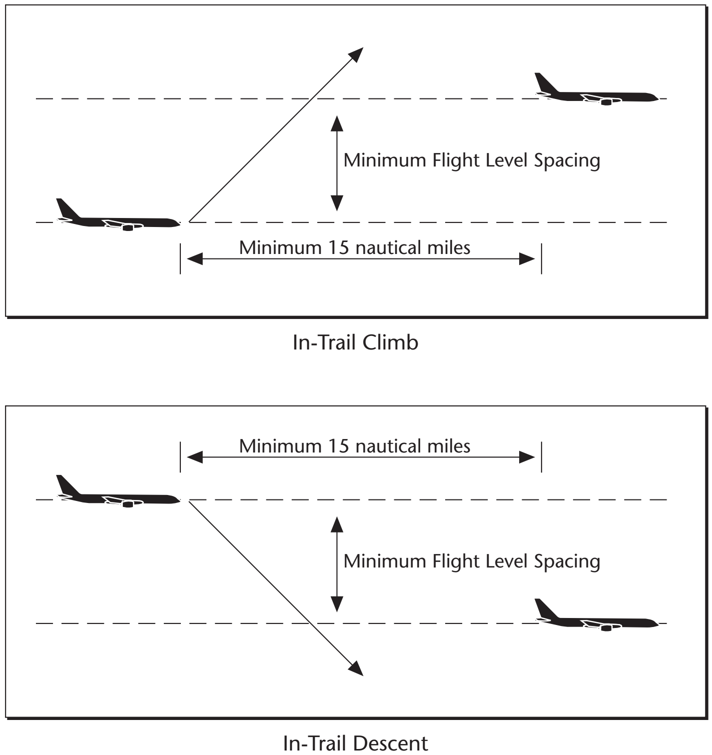


Figure 5-2.

In-Trail Climb and In-Trail Descent

Dynamic Aircraft Route Planning (DARP)

The DARP initiative provides the ability to update/revise a flight route while an aircraft or a group of aircraft is en route. This will allow a user to take advantage of a more efficient trajectory when a revised forecast is published by the traffic management unit (including real-time weather and winds information) in order to optimize the route of flight. An aircraft may take advantage of this trajectory for the remainder of its route, saving time and fuel. In 1997, the FAA began oceanic trials of the DARP between Los Angeles and Sydney.

Terminal Area/Approach Procedures

There are a number of visual and electronic landing aids at or near airports that assist pilots in locating the runway, particularly during IFR weather conditions. Approach procedures have been developed based on the type and accuracy of landing aids available. Some of these approach procedures are discussed below.

Area Navigation (RNAV) Approaches

With the capabilities enabled by RNAV technologies such as GPS and FMS, the availability and number of approach procedures to airports can be increased. GPS, unlike other RNAV technologies, is capable of providing precise vertical and horizontal guidance to a runway. This capability will enable the development of precision approaches during low weather minimums to airports not having precision landing aids today. By accelerating the publication of RNAV approach procedures, air traffic services (ATS) will increase access to the Nation's airports during IFR weather conditions. ATS plans to publish a minimum of 500 non-precision RNAV approaches per year over the next three years.

Simultaneous Converging Instrument Approaches

Under existing approach procedures, converging runways can be used for independent streams of arriving aircraft only when the ceiling is at least 900 - 1,000 feet and visibility is at least three statute miles. This requirement decreases runway capacity in instrument meteorological conditions (IMC) and causes weather-related delays. Simultaneous approaches cannot be conducted under IMC if the converging runways intersect.

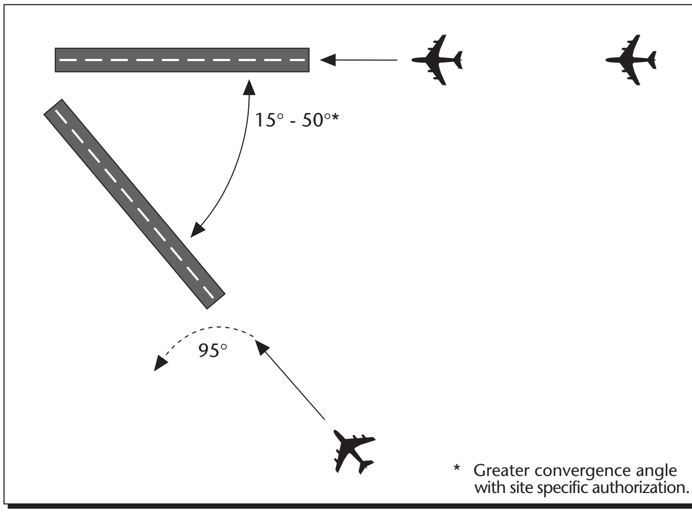
In an effort to refine the converging approach procedures and obtain greater operational efficiency for the users, the Converging Approach Standards Technical Work Group (CASTWG) was formed. The goal of the workgroup is to reduce landing minimums for aircraft conducting simultaneous converging instrument approaches, using FMS technology and new procedures to ensure required aircraft separation is provided in the event of a simultaneous missed approach.

The CASTWG developed and tested a new missed approach procedure using a 95 degree turn from the localizer course, which can be implemented at 650-feet minimums. The procedure requires flight testing and validation prior to initial implementation. Once the new 650-feet minimums are implemented, efforts to further reduce the minimums to as low as 500 feet will continue.

Average capacity gains using the new minimums with FMS positive missed approach guidance are expected to be 30 arrivals per hour. When the new procedure is used in conjunction with other approaches, annual delay savings of more than 12,000 hours are projected for Chicago O'Hare, one candidate for the new procedure.

Average capacity gains using the new minimums with FMS positive missed approach guidance are expected to be 30 arrivals per hour.

Figure 5-3 illustrates the missed approach for the new simultaneous converging instrument approach and lists candidate airports for the new procedure.



Candidates Among Top 100 Airports
Boston
Charlotte
Chicago O'Hare
Dallas-Ft. Worth
Houston Intercont'l
Miami
Nashville
New Orleans
Newark
Philadlephia
St. Louis
Salt Lake City
Washington Dulles

Figure 5-3.

Independent Converging Approach and Missed Approach Procedure

Removal of 250 Knot Speed Limit for Departing Aircraft in Class B Airspace

Currently aircraft are restricted to a 250 knot speed limit below 10,000-feet mean sea level (MSL). This restriction constrains capacity by limiting departure rates. Laboratory simulations for St. Louis and Dallas/Fort Worth terminal areas indicated that removing the speed limit resulted in no major safety concerns, insignificant noise impacts, and no appreciable change in controller workload. In June 1997, the FAA began a field program at George Bush Intercontinental Airport, Houston International TRACON to determine the feasibility and impact of removing the 250 knot speed restriction for aircraft departing in Class B airspace. Under the field program, there are three test procedures. The first test procedure is to allow controllers to remove the 250 knot speed limit when operationally advantageous. The second test procedure will allow aircraft to exceed 250 knots after reaching a particular altitude. The third test procedure will allow aircraft to climb at an unrestricted speed at the pilot's discretion. Interviews with controllers and users conducted in August 1997 indicated that the flight crews were enthusiastic supporters of the concept, while controllers view their authority to remove restrictions as a valuable tool to enhance the efficiency of departure flow.

CHAPTER 6: CAPACITY ENHANCING TECHNOLOGIES

Over the next two decades, the FAA will introduce numerous technologies to the civil aviation system that promise to improve safety, increase capacity, reduce delays, provide greater flexibility and predictability, and improve the overall efficiency of the National Airspace System (NAS). Worldwide, civil aviation authorities and airspace users are adopting many of these technologies as part of the transition from traditional air traffic control (ATC)—a system based on radio communications, radar surveillance, and ground-based navigation—to a more flexible and efficient airspace management system using digital communications, satellite navigation, and advanced processors.

The technologies identified in this chapter were selected based on their projected benefits to airspace and airport capacity. While emphasis is placed on new and developing technologies, it is understood that many capacity improvements will also be gained from incremental upgrades to existing systems or new applications of existing technology. Technologies discussed in this chapter are described in more detail in the FAA's Capital Investment Plan (CIP), Plan for Research, Engineering, and Development (R,E&D), and NAS Architecture.

This chapter is divided into five areas: Communications, Navigation, Surveillance, Weather, and Air Traffic Management. For each area, the characteristics of the current system are described, followed by a description of planned enhancements and the key technologies that will make those enhancements possible. A table listing all of the currently funded capacity-enhancing technology projects is presented for each area.

Communications

The exchange of information is vital to all flight operations. This is especially true for large commercial operations that require continual interaction with flight planning and ATC facilities to obtain information concerning weather forecasts, clearances, taxi instructions, expected delays, position reports, air traffic advisories, airport information, etc. Problems in the communication system, such as frequency congestion and interference, impact the overall efficiency of operations. Planned improvements to the communications systems will greatly improve the quality, clarity, and amount of information exchanged among and between aircraft and ground facilities.

Current Communication Capabilities

In domestic airspace, information is typically transmitted and received using voiced air/ground ultra high frequency (UHF) and very high frequency (VHF) radio. As the number of aircraft operations has grown and the demand for information exchange continues to rise, frequency congestion has become increasingly problematic, especially within terminal airspace. This congestion limits the effectiveness of communication, increases controller/pilot workload, creates delays, and increases the likelihood of missed or misinterpreted information. Frequency congestion is largely a result of increased demand for the spectrum available to the FAA. Los Angeles, Chicago, New York, and Atlanta airspace are already out of available channels. By 2004 - 2007, the FAA will be unable to provide additional channel assignments.

In oceanic airspace, long-range air/ground communication is performed through third-party high-frequency (HF) radios—a communication system that is often hampered by lengthy delays and subject to atmospheric interference. The shortcomings inherent in the HF radio system make position reports and ATC approvals for routine pilot clearance requests (i.e., altitude changes for favorable winds) difficult to obtain due to uncertainties concerning the location of nearby air traffic.

Planned Communication Enhancements

Limited spectrum availability is a major driving force in transitioning to digital communications.

Limited spectrum availability is a major driving force in transitioning to digital communications. Between now and 2003, the NAS will add digital communication capabilities through the expanded use of UHF and HF data link services. The FAA expects a spectrum recovery of 3.8 digital channels for each current analog channel. As a result, communication capabilities among aircraft and ground facilities will be enhanced to increase the volume of information being transmitted while minimizing frequency congestion, interference, delays, and misunderstandings. Data, especially in the form of text and graphical information, will constitute a much larger portion of all air/ground communications than today. Further, wireless information will be made more available as worldwide aeronautical communication networks are developed.

Aeronautical Data Link System

The term data link refers to the overall system for entering, processing, transmitting and displaying information. Data link technology is designed to transmit and receive air/ground voice, alphanumeric, and graphic information. Although some commercial operators already use these technologies to alleviate frequency congestion and improve communications, current data link architecture is limited to alphanumeric information in terminal and airport environments.

Improvements planned for data link will expand and enhance communications on the airport surface and during all phases of flight, and will facilitate more accurate and reliable communications between flight crews in oceanic airspace. Expanded use of data link technologies in the cockpit will also increase the effectiveness of pilot and air traffic management collaborative decision making. Data link's ability to handle large volumes of data will allow for greater on-demand access to airport information; arrival, departure, and taxi schedules; airborne and surface surveillance information; NAS infrastructure status; and real-time weather information. This communication system will shift from analog to digital, make more use of satellites as a transmission media, and reduce congestion and frequency interference associated with today's analog-based communication systems. Specific data link projects include Ocean Data Link (ODL), which will greatly expand oceanic communications, and Controller to Pilot Data Link Communications (CPDLC), which will improve the speed and reliability of controller to pilot communications and contribute to overall NAS safety and capacity. Current data link services will be expanded between 2000 and 2005 to provide services in all phases of flight.

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Aeronautical Telecommunication Network (ATN)

An integral component of the data link system is the Aeronautical Telecommunication Network (ATN). The ATN is a worldwide data network intended to provide data communications connectivity among mobile platforms, airlines, and other companies that provide services. The ATN will allow a collection of dissimilar transmission networks and interconnecting computers to operate as a single, cooperative network. The goal is to provide full and flexible support for data communications between aviation end-users around the world—both fixed-based and mobile.

Next Generation Air/Ground Communication System (NEXCOM)

The Next Generation Air/Ground Communication System (NEXCOM) will provide air/ground communications in support of safety-critical ATC services. This project will provide radio system equipment to satisfy the FAA's need to replace existing unmaintainable radios and increase the capacity of the VHF spectrum. When fully operational, NEXCOM will:

- Provide air traffic controllers with the ability to accommodate the growing number of sectors and services using the available, limited radio frequency spectrum;

- Reduce logistical costs by replacing expensive to maintain VHF and UHF radios;
- Provide new data link communications capability to all user classes;
- Reduce air/ground radio frequency interference and provide security mechanisms to identify unauthorized users; and
- Recover critically needed VHF channels through improved spectrum utilization.

NEXCOM will meet the needs of the increasing number of NAS users and will satisfy the current and identified future requirements that cannot be met using the current voice communications system. Based on the VHF digital link standards defined by the International Civil Aviation Organization (ICAO), the new digital radio system will permit rapid failure detection and recovery to meet air/ground service availability requirements. It will also provide compatible interfaces with voice switches and aeronautical telecommunications network elements at control facilities. An investment decision is expected by March of 1998, and initial operational capability is expected in 2005.

Table 6-1 identifies and describes communications programs and technologies that will contribute to capacity enhancement. The projects are listed with CIP and R,E&D identification numbers for reference purposes.

Navigation

Aviation navigation systems in use today vary considerably in terms of accuracy, coverage, and capabilities. The current navigational airways structure and most approach and landing charts are designed principally around the geographic location and technical characteristics of ground-based navigational aids. Future initiatives will enhance the current navigation system by using a more flexible and available satellite-based system.

Current Navigation Capabilities

The primary means of aircraft navigation in the United States today is the VHF omnidirectional range (VOR) — a system made up of a series of ground stations that broadcast directional signals. These signals are used by aircraft to determine bearings to or from VOR stations. If the VOR and aircraft are equipped with Distance Measuring Equipment (DME), the signals can also be used to determine the distance to VORs. Navigating using VORs typically consists of flying airways (specific radials connecting VOR stations). The location of VOR stations often leads to indirect, inefficient flight paths between an aircraft's origin and destination.

Table 6-1.

Communications Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Voice Switches	C-05	Airport, Terminal, En Route	This project will provide modern voice switching equipment for terminal radar approach control (TRACON) facilities, large consolidated TRACON facilities, and airport traffic control towers. The new voice switching capabilities will enable air traffic controllers to communicate with aircraft and each other to manage traffic flows.
FAA Telecommunications Satellite (FAATSAT)	C-15	Flight Service Stations, Terminal, En Route/Oceanic	This project provides the FAA with a leased service and a diverse, alternative path for primary interfacility telecommunications circuits–with the goal of avoiding single points-of-failure. It will be a cost-efficient way to meet NAS service availability and message quality requirements.
Aeronautical Data-link System (ADLS)	C-20	Airport, Terminal, En Route/Oceanic	ADLS will develop the hardware and software needed for non-critical air traffic control communications between pilots and air traffic controllers, provide en route applications, and implement controller-to-pilot data link communications. This will improve pilot accessibility to information, relieve congested voice frequencies, and reduce the workload of pilots, specialists, and air traffic controllers.
Next-Generation Air/Ground Communications System (NEXCOM)	C-21	Flight Service Stations, Airport, Terminal, En Route/Oceanic	This program will design, implement, and install a new air/ground radio communications system. It will replace obsolete, unmaintainable analog controller-to-pilot radios with multimode radios having digital voice and data link capability, provide new information exchange functions, and increase very high frequency (VHF) band spectrum use.
Aeronautical Data Link Communications and Applications	031-110	R,E&D, En Route, Oceanic, Terminal, Airport	This project will develop and validate domestic and international data communications standards associated with the Aeronautical Telecommunications Network (ATN) and special purpose air/ground data link capabilities. The two major elements of this Data Link program are communications and applications. The communications element includes the development of the automatic dependent surveillance broadcast (ADS-B) concept; concurrently, the key enabling applications to permit efficient flight crew to controller communications will be developed. The enhanced ATN communications capabilities provided by data link will facilitate improved airspace utilization and reduced delay and operating expenses.
Satellite Communications Program	031-120	R,E&D, En Route, Oceanic, Terminal, Airport	This project will develop the standards and perform required testing to support mobile satellite communication (SATCOM) operational use as an oceanic subnetwork to the ATN. This program is integrated with the Aeronautical Data Link Communications and Applications and the Oceanic Air Traffic Automation R,E&D programs to achieve increased safety, help reduce separation standards, and provide direct, reliable communications in the oceanic and remote areas.

However, some avionics are capable of interpreting VOR and/or DME signals to provide Area Navigation (RNAV), allowing for more direct routing of flights. Most new air carrier and similarly equipped aircraft have a flight management system (FMS) with multiple DMEs that improve RNAV VOR accuracy.

Landing navigational systems are similar to and in some cases the same as en route systems. Landing aids are classified as precision and non-precision. Precision landing aids refer to systems that can, with a high degree of accuracy, align an aircraft's vertical and horizontal path with a runway to allow for low visibility landings. The Instrument Landing System (ILS) is the primary system used for precision navigation today. The capabilities of ILS systems are defined in three categories, with Category I being the least accurate and Category III being the most accurate. Non-precision landing aids typically refer to the use of en route navigational aids or a limited component of precision aids (e.g., ILS localizer only), to place aircraft within the proximity of a runway, allowing for a visual approach to landing.

Planned Navigation Enhancements

The satellite navigation system in use today will become more accurate and available and have greater integrity. Current capabilities will be further augmented by ground facilities that will allow for precision guidance to landing, thereby expanding the number of precision approaches available during instrument meteorological conditions.

Global Positioning System (GPS)

An alternative to land-based navigation and inertial guidance systems for both en route and terminal environments is the satellite-based U.S. Global Positioning System (GPS). The GPS system was developed by the military and has been in use by civil aviation since the early 1990s. Currently, the GPS system consists of a 24 satellite constellation, plus associated ground-based monitoring and control facilities. The satellites transmit precisely timed signals coded so that a receiver on or near the surface of the earth can calculate position information. The system is accurate, easy to use, and provides worldwide coverage. GPS also gives horizontal and vertical position information, a capability lacking in ground-based navigational aids (with the exception of certain precision landing aids). These combined attributes allow for more flexible arrival, departure, and low altitude random direct routes; reduced separation standards; precision approach and missed approach guidance to all runways; and streamlined procedure and naviga-

An alternative to land-based navigation and inertial guidance systems for both en route and terminal environments is the satellite-based U.S. Global Positioning System (GPS).

tion techniques. GPS has been extensively tested and is already being used as a primary means of navigation in the oceanic environment.

GPS Wide Area Augmentation System (WAAS)

The Wide Area Augmentation System (WAAS) is an augmentation of GPS that includes integrity broadcasts, differential corrections, and additional ranging signals. It is being developed to provide the accuracy, integrity, availability, and continuity required to support all phases of flight through Category I precision approaches. WAAS consists of a network of wide area ground reference stations that receive and monitor the GPS signals. Data from these reference stations are transmitted to master stations, where the validity of the signals from each satellite is assessed and wide area corrections are computed. These validity (integrity) messages and wide area corrections also act as additional sources of GPS ranging signals, giving the user a direct verification of the integrity of the signal from each satellite in view. The system is scheduled to reach its initial operational capability in 1999. Additional satellites and ground stations will be added to enable it to serve as a primary system for air navigation and precision landing capabilities for Category I operations in 2001.

GPS Local Area Augmentation System (LAAS)

The Local Area Augmentation System (LAAS) is an augmentation of GPS that will be needed for operations down to CAT II/III precision landing minimums. This system relies upon a precisely surveyed ground station within the terminal area to calculate differential correction and integrity information, which it then transmits to aircraft within line-of-sight coverage, typically providing an operational radius of up to 25-30 nautical miles. One LAAS system can provide service for multiple runways as long as they are within the LAAS operational range. LAAS can also provide terminal navigation, airport surface navigation, and guided missed approach and departure procedures. Minimum operating performance standards are scheduled to be completed by the middle of 1998; validation testing is scheduled to be completed by the end of 2001. By making precision approach procedures available to more airport runways and extending precision navigation to the airport surface, the LAAS will improve the safety and capacity of airports and surrounding airspace.

By making precision approach procedures available to more airport runways and extending precision navigation to the airport surface, the LAAS will improve the safety and capacity of airports and surrounding airspace.

Table 6-2 identifies and describes navigation programs and technologies that will contribute to capacity enhancement. The projects are listed with CIP and R,E&D identification numbers for reference purposes.

Table 6-2.

Navigation Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Instrument Landing System (ILS)	N-03	Airport	This program will establish new Category I (CAT I) ILS installations and provide operations and maintenance funding to sustain existing CAT I Mark-IA ILS installations until global positioning system (GPS) precision approaches are available.
Runway Visual Range (RVR)	N-08	Airport	This program establishes new generation runway visual range systems to support precision landing operations and airport capacity enhancements. It also provides advanced microprocessor technology, remote maintenance monitoring capability, and resistance to poor weather conditions.
Augmentations for the Global Positioning System (GPS)	N-12	Airport, Terminal, En Route/Oceanic	This program enables the satellite-based GPS to function as the single FAA radio navigation system for all oceanic and domestic phases of flight. Two specific projects involved in this program are the Wide Area Augmentation System (WAAS) and the Local Area Augmentation System (LAAS). WAAS will provide a wide area network of precisely located monitors, reference stations, master control stations, leased satellites, and ground uplinks. LAAS will augment GPS to allow precision runway approaches in geographical areas not covered by WAAS. GPS will reduce the interdependency of proximate airports by improving an airport's surrounding airspace capacity.
Satellite Navigation System	032-110	R,E&D, En Route/Oceanic, Terminal, Airport	This program will develop augmentations to navigation satellites (e.g., GPS) to support techniques, procedures, and standards to meet all civil aviation navigation needs. Satellite navigation presents opportunities for standardized worldwide civil aviation operations using a common navigation receiver and for significant improvements in safety, capacity, service, flexibility, and operating costs.

Surveillance

Knowing the position and intended path of aircraft relative to other aircraft — both on the ground and in the air — is necessary to ensure safe separation. The accuracy and certainty with which aircraft positions can be tracked determines the procedures and spacing allowed to maintain safe operations. Enhancing surveillance improves the efficiency of airspace usage by reducing separation requirements. In order to realize reduced separation standards, the free flight concept imposes particularly high demands on the ability to accurately and reliably locate and track the movement of aircraft with greater precision and a faster update rate than is used today.

Current Surveillance Capabilities

Separation is ensured today by visual confirmation, radar imaging, and pilot position reports. Visual separation is common in both general aviation and commercial air transport operations, though its use is limited to clear weather conditions. Radar imaging allows air traffic controllers to see a wide view of aircraft movements and makes possible the task of monitoring and sequencing large numbers of aircraft. Pilot position reports are used particularly in areas where radar coverage is poor or absent and where visual contact cannot be assured.

In order to realize reduced separation standards, the free flight concept imposes particularly high demands on the ability to accurately and reliably locate and track the movement of aircraft with greater precision and a faster update rate than is used today.

Planned Surveillance Enhancements

Surveillance coverage and accuracy will be enhanced by incorporating aircraft navigation information with existing radar. This information will be translated into 4-D (four dimensional - position plus time) position information and made available to pilots and controllers to enhance situational awareness, improve the efficiency of aircraft spacing, allow for greater route flexibility, and heighten conflict avoidance capabilities.

Automatic Dependent Surveillance (ADS)

To augment existing surveillance procedures and radar, a new system known as Automatic Dependent Surveillance (ADS) will be used. Unlike radar, which tracks aircraft using interrogating radio signals, ADS transmits position reports based on onboard navigational instruments. ADS relies on data link technologies to transmit this information. Presently there are two forms of ADS: ADS-Address (ADS-A) and ADS-Broadcast (ADS-B). The ADS-A system exchanges point-to-point information between a specific aircraft and air traffic management facility upon request; the

ADS-B system broadcasts information periodically to all aircraft and all air traffic management facilities within a specified area. The primary objective of ADS-A and ADS-B technology is to improve surveillance coverage, particularly in areas having poor or no radar coverage.

In the oceanic environment, where separation is now maintained through pilot position reports, the use of ADS will have a particularly beneficial impact.

When ADS-equipped aircraft are within radar coverage, their positions will be verified by radar reports, providing independent and redundant surveillance. In areas not covered by radar, ADS will allow separation requirements for participating aircraft to be reduced from current procedural separation standards, providing greater capacity and increased approvals of user preferred routes and altitudes. In the oceanic environment, where separation is now maintained through pilot position reports, the use of ADS will have a particularly beneficial impact. Optimum altitudes and speeds will be achieved through the expanded use of oceanic in-trail climb and descent procedures and aircraft will have the flexibility to change routes mid-flight if winds are not as forecasted. Because separation requirements will be reduced, more efficient merging of traffic from multiple oceanic tracks onto arrival routes will be possible.

On the airport surface, ADS will be used to assist in taxi operations. ADS-equipped aircraft will be displayed directly to flight crews and air traffic controllers on an appropriate overlay map. This capability will give the flight crew information to better evaluate the potential for runway and taxiway incursions, especially at night or in poor visibility, than is available today. The FAA plans to add ADS-A capabilities in Oakland and New York oceanic airspace in the year 2000. Initially, ADS-B will enable aircraft-to-aircraft transmission of position information from GPS, aircraft identification, and intent information. With deployment of STARS and replacement of the Host computer, the FAA can begin to receive ADS-B reports for display to the controller. The FAA will initially use interrogation of the aircraft to receive the ADS-B information, then add additional ground stations to increase surveillance coverage. A fully operational ground system is not scheduled until 2008.

Table 6-3 identifies and describes surveillance programs and technologies that will contribute to capacity enhancement. The projects are listed with CIP and R,E&D identification numbers for reference purposes.

Table 6-3.

Surveillance Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
ASDE Radar and Airport Movement Area Safety System (AMASS)	S-01	Airport	The ASDE-3 provides radar surveillance of aircraft and airport service vehicles at selected airports to ensure an effective mode of directing and moving surface traffic. AMASS provides visual and aural alerts to potential and actual surface conflicts. When combined, ASDE-3 and AMASS provide a near-term solution to prevent runway incursions.
Mode S, Secondary Surveillance	S-02	Airport, Terminal, En Route/Oceanic	Mode S will improve the surveillance capability of the air traffic control radar beacon system (ATCRBS). It provides more accurate positional information and minimizes interference. The program replaces aging and obsolete air traffic control beacon interrogator (ATCBI-4/5) equipment with a new mono-pulse secondary surveillance radar (MSSR) system.
Multilateration Technology	S-02/S-08	Airport	The purpose of this project is to provide a demonstration prototype of the multilateration approach to monitoring final approaches to parallel runways. The multilateration approach represents a low-cost alternative to prescision runway monitor (PRM) that uses multiple air traffic control radar beacon (ATCRB) transponders and Mode S to provide accurate surveillance capability for monitoring final approaches to closely spaced parallel runways.
Terminal Radar (ASR) Program	S-03	Airport, Terminal	This program replaces obsolete, logistically unsupportable airport surveillance radars with modern digital equipment compatible with the standard terminal automated radar system (STARS) and upgrades en route and secondary surveillance radars.
Long-Range Radar Program (LRR)	S-04	En Route/Oceanic	This project will provide a national radar surveillance network by installing the air route surveillance radar at existing and new sites. It will improve the current inventory of long-range radars that will extend their useful life and/or aid the transition to a beacon-only en route surveillance system.
Precision Runway Monitor (PRM)	S-08	Airport	This project developed a high-up-date-rate radar and computer predictive displays that reduce the allowable runway spacing for conducting independent parallel instrument approaches at closely-spaced runways. Conducting independent approaches will enable airports to increase throughput capacity, reduce delays, and save fuel during reduced visibility.

Weather

Weather is the single largest contributor to delay in the civil aviation system and is a major factor in aircraft safety incidents and accidents. Short-term forecasts and timely, accurate weather information on hazardous weather are critical to ensure safe flight and to plan fuel and time-efficient flight plans.

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Many of the inefficiencies in today's weather system can be attributed to limitations in the accuracy, predictability, analysis, transmission, coordination, and display of weather data. To mitigate these issues, the FAA will incorporate technologies and procedures to improve the dissemination of consistent, common, and timely aviation weather information in graphical format to all users of the aviation system, both ground and airborne. Further, weather information will be improved through the use of better sensors, sophisticated computer modeling, and new automated systems.

Current Weather Capabilities

The timeliness and reliability of weather information available to pilots and air traffic controllers is largely determined by the degree of communication and coordination among the many organizations and systems that gather and disseminate that information. The technical systems used to gather, report, and forecast weather range from obsolete to state-of-the-art. The weather systems in use today can be characterized as good in predicting large area forecasts (e.g., movement of fronts) but less capable of predicting the exact timing, location, and severity of local phenomena (e.g., thunderstorms).

Planned Weather Enhancements

The FAA is working in conjunction with other agencies such as NASA and the National Oceanic and Atmospheric Administration (NOAA) to improve NAS capacity though better forecasting, detection, and dissemination of adverse weather conditions. Other weather-related technology enhancements include new information systems designed to integrate a wide range of weather data into a single database where it can be analyzed using new models. The output of these analytic tools will be displayed in the form of enhanced graphics on new display systems in ATC facilities and in the aircraft cockpit. The data link system will be an essential element in the timely dissemination and coordination of weather information to flight crews.

The FAA is working in conjunction with other agencies such as NASA and the National Oceanic and Atmospheric Administration to improve NAS capacity though better forecasting, detection, and dissemination of adverse weather conditions.

Integrated Terminal Weather System (ITWS)

The Integrated Terminal Weather System (ITWS) is a fully-automated weather-prediction system that will give air traffic personnel and pilots enhanced information on weather hazards in the airspace within 60 nm miles of an airport. When fully implemented, ITWS will have the capability to generate predictions of weather phenomena such as microbursts, gust fronts, storm cell movements, and runway winds up to ten minutes in advance. Additionally, the system will display weather data in tower cabs, terminal radar approach control facilities, and their associated air route traffic control centers to facilitate coordination among air traffic control personnel. This system is a step toward avoiding delays caused by localized, hazardous weather and will increase the margin of safety. In addition, ITWS will improve traffic flow due to earlier warnings of weather impacts to an airport.

When fully implemented, ITWS will have the capability to generate predictions of weather phenomena such as microbursts, gust fronts, storm cell movements, and runway winds up to ten minutes in advance.

Weather and Radar Processor (WARP)

Meteorologists working in the weather units of ATC centers do not have an integrated system for collecting and displaying multiple weather sensor inputs. The Weather and Radar Processor (WARP) will collect and process weather data from Low Level Windshear Systems (LLWAS), Next Generation Weather Radar (NEXRAD), Terminal Doppler Weather Radar (TDWR) and surveillance radar, and disseminate this data to controllers, traffic management specialists, pilots, and meteorologists. WARP will also provide meteorologists with automated workstations that improve their ability to analyze rapidly changing weather conditions. By providing a mosaic of weather information to advanced display systems, the WARP will assist air traffic management in minimizing weather-related delays.

Table 6-4 identifies and describes weather programs and technologies that will contribute to capacity enhancement. The projects are listed with CIP and R,E&D identification numbers for reference purposes.

Table 6-4.

Weather Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Automated Weather Observing System (AWOS)	W-01	Flight Service Stations, Airport, En Route/Oceanic	AWOS processes aviation-critical weather data from automated sensors and disseminates information to pilots by computer generated voice radio transmissions. The connection of AWOS with the automated weather observation system data acquisition system (ADAS) will make current weather observation data accessible to pilots and controllers, enhancing safety and efficiency.
Weather Radar Program (NEXRAD)	W-02	En Route/Oceanic	NEXRAD provides a national network of Doppler weather radars to detect, process, distribute, and display hazardous weather information. Automated ATC capabilities, such as preferred routing and improved flow management, will require this type of accurate aviation weather data for en route applications.
Terminal Doppler Weather Radar (TDWR) System	W-03	Airport, Terminal	This program involves the installation of a new terminal Doppler weather radar that can detect microbursts, gust fronts, wind shifts, and precipitation. It will warn aircraft in the terminal area of hazardous weather conditions and of changing wind conditions to enable the timely change of active runways.
Weather and Radar Processor (WARP)	W-04	En Route/Oceanic	The WARP will collect, process, and disseminate weather information from next generation weather radars (NEXRAD) to air traffic controllers, traffic management specialists, pilots and meteorologists. By providing a mosaic product of NEXRAD data to the Display System Replacement (DSR), the WARP will enhance the quality of weather information available to air traffic controllers, thus reducing accidents and air traffic delays. It also provides center weather service unit/ central flow weather service unit meteorologists with automated workstations that improve their ability to analyze rapidly changing weather conditions.
Low-Level Windshear Alert System (LLWAS)	W-05	Airport	The LLWAS provides local controllers and pilots with information on microbursts and windshear near airports. This program will increase the probability of microburst and windshear detection through system expansion and upgrades. Planned upgrades will refurbish the LLWAS system to make it logistically supportable for at least 15 years.

Table 6-4.

Weather Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Integrated Terminal Weather System (ITWS)	W-07	Terminal	The ITWS will integrate relevant weather data accessible in the terminal area and from in-flight aircraft to provide air traffic personnel with timely, near-term weather information and predictions in a clear graphical and textual form. This program will deploy ITWS product generators to 34 TRACONs.
ASR Weather Systems Processor	W-09	Terminal	This program enhances the hazardous weather detection capability of an airport surveillance radar by developing and testing a modular data processing channel for automatic detection of windshear, thunderstorm microbursts, and gust fronts. The advancement provides airports ineligible for terminal doppler weather radars with windshear warnings.
Aviation Weather Analysis and Forecasting	041-110	Aircraft/Aircrew, Flight Service, Airport, Terminal, En Route, R,E&D	The integration of this project with other national research programs that focus on atmospheric mesoscale analysis and prediction problems will improve the understanding of weather's effects on aviation. An additional purpose is to concentrate research efforts on developing new algorithms, numerical weather analysis and prediction models, and methods to detect the impact from weather hazards. This research will significantly improve weather product and forecast quality, thus enabling aviation weather users to make effective strategic and tactical decisions for aviation operations.
Aeronautical Hazards Research	042-110	Aircraft/Aircrew, Terminal, En Route, R,E&D	Designed to improve safety, the project will collect data and analyze systems to validate technology for detecting hazards such as mountain rotors. The research will improve the operational capability to detect, monitor and alert flightcrews to aeronautical hazards.
Low Visibility Landing and Surface Operations (LVLASO)	NASa	Airport, Terminal	The goal is to improve the efficiency of airport surface operations for commercial aircraft operating in weather conditions to Category IIIB while maintaining a high degree of safety.

Air Traffic Management

Air traffic management requires gathering and processing large volumes of data to make effective decisions according to ever changing conditions. The development of automated decision support systems will improve the effectiveness of air traffic information and yield more efficient use of airspace.

As the volume of air traffic increases and as procedures allow greater pilot discretion, the efficient management and monitoring of air traffic will require the use of more advanced decision support systems.

Current Automation/Decision Support Capabilities

Air traffic controllers today use a combination of procedures and automated systems to separate traffic. The decision support systems in use today, however, provide only limited assistance to air traffic controllers. Most routine decisions are made based on the training, experience, and judgment of the individual controllers who must follow a set of narrowly defined air traffic procedures. As the volume of air traffic increases and as procedures allow greater pilot discretion, the efficient management and monitoring of air traffic will require the use of more advanced decision support systems.

Planned Decision Support Enhancements

Numerous technologies are being developed to ensure the efficient and effective collection, transfer, and display of information. Decision support systems will augment these initiatives by coordinating information (e.g., flight plans, weather forecasts, infrastructure status, traffic densities, etc.) from multiple ground, air, and space-based sources and processing this information to improve the effectiveness of tasks such as flight planning, traffic sequencing, conflict checking, and conflict resolution. The integration of these data provides the opportunity for new analytic tools that controllers and/or flight crews may use to plot fuel efficient routes, identify potential conflicts with other aircraft, or adjust routes during flight. Graphical output from these analytic tools will assist users in decision making. The tools will enable controllers throughout the system to simultaneously provide greater flexibility, reduce delays in congested airspace, and enhance overall safety.

Standard Terminal Automation Replacement System (STARS) and Display Replacement System (DSR)

The Standard Terminal Automation Replacement System (STARS) will replace outdated air traffic control computers with 21st century systems at nine large consolidated TRACONs and approximately 152 FAA and 60 DOD terminal radar approach control sites across the country. STARS will support radar target identification and separation, traffic and weather advisory services, and navigational assistance to aircraft. STARS will also provide safety functions such as conflict alert and minimum safe altitude warning. Improvements, such as improved weather displays, will be introduced on the STARS platform to support air traffic management decision support functionality. The FAA expects to have the first STARS operational by December 1998, with subsequent deliveries to the FAA and DOD facilities scheduled through 2007.

The STARS' counterpart for en route airspace is the Display System Replacement (DSR). DSR will provide air traffic controllers with a modern digital display system capable of processing and providing information in a fast, reliable manner. DSR will support a conflict probe capability.

Collaborative Decision Making (CDM) - Build 1

Part of the larger Air Traffic Management Program (ATM), the Collaborative Decision Making (CDM) program was initiated in an effort to improve traffic flow management by establishing closer collaboration between the FAA and the airlines. By using automated systems to establish accurate pictures of real-time schedule information, the FAA will be better able to determine actual and projected traffic flow demands at major airports. As the NAS becomes more congested, the efficient use of resources will become more important to both the FAA and NAS users. This improved communication with the airlines will help to eliminate some ground delay programs (GDPs), reduce the scope and duration of other GDPs, and allow NAS users more flexibility in responding to airport arrival constraints.

By using automated systems to establish accurate pictures of real-time schedule information, the FAA will be better able to determine actual and projected traffic flow demands at major airports.

Build 1 of CDM consists of several components including: the Flight Schedule Monitor (FSM) software, which displays arrival information, monitors ground delay situations, measures ground delay performance, and provides traffic managers with a "what-if" analysis capability for projecting scenarios and arrival rates; the Ration-by-Schedule function, which uses the schedule defined in the *Official Airline Guide* (OAG) as the baseline for allocating arrival slots to NAS users; the Schedule Compression function, which moves participating flights into newly available slots, thereby compressing the departure schedule and reducing assigned delays; the Data Exchange capability, which enables the airlines and the command center to send and receive the real-time schedule and demand information; and Flow Management Decision Support Enhancements, which includes utility functions for both traffic managers and NAS users that are user-friendly and permit "what-if" analysis. All of these features facilitate information exchange between NAS users and air traffic service providers.

Center Terminal Radar Approach Control Automation System (CTAS)

The CTAS will provide users with airspace capacity improvement, delay reductions, and fuel savings by introducing computer automation to assist controllers in efficiently descending, sequencing, and spacing arriving aircraft. CTAS will provide two major functional capabilities in the near term: single center traffic management advisor (TMA) and passive final approach spacing tool (pFAST). The TMA will provide en route controllers and traffic management coordinators with automation tools to manage the flow of traffic from a single center into selected major airports. It will result in estiamed delay reductions of one to two minutes per aircraft during peak periods. pFAST will help controllers select the most efficient arrival runway and arrival sequence within 60 nm of an airport, resulting in increased arrival throughput. The FAA is planning to implement TMA at 15 ARTCCs between the years 2002 and 2004, and pFAST at 22 TRACONs between 2002 and 2006.

Long term improvements for CTAS include: multi-center TMA capability, required when multiple ARTCCs meter arrivals into a single terminal; descent advisor, which will provide optimized descent point and speed advisories to controllers based on aircraft type; and active FAST, which will help controllers determine how to vector aircraft onto final approach.

Initial Conflict Probe (ICP)

The Initial Conflict Probe will provide controllers with the ability to look ahead to identify potential separation conflicts with greater precision and accuracy. By estimating current position and predicted flight paths, ICP checks for potential loss of separation at current and future times. This system can be triggered automatically or manually.

The ICP display supports the strategic planning function and reduces the use by air traffic controllers of manual flight strips. Other potential benefits of ICP include conflict detection in oceanic airspace, greater route flexibility during weather changes, relaxed boundary restrictions, and more efficient routings provided well in advance of, rather than close to, the conflict. The FAA implemented the User Request Evaluation Tool, a prototype ICP, as a daily-use probe at the Indianapolis Center in 1997. It will be implemented at the Memphis Center in 1998. Field upgrades to ICP will also occur in 1998.

Table 6-5 identifies and describes automation/decision support programs and technologies that will contribute to capacity enhancement. The projects are listed with CIP and R,E&D identification numbers for reference purposes.

Table 6-5.

Decision Support System Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
En Route Automation Program	A-01	En Route/Oceanic	Projects in this program will replace aging and unsupportable equipment and allow continued system growth in the present ATC system, providing a safe and efficient air traffic environment that contributes to the move toward a free flight environment.
Tower Automation Program (TAP)	A-02	Airport	The program will integrate new and existing safety systems in a consolidated automation platform with a common computer/human interface. TAP will solve the problems of controllers having minimal flexibility to rearrange operational positions for various tower operating conditions and the inefficient placement of individual control systems.
Automated Radar Terminal System (ARTS) Improvements	A-03	Terminal	This program will provide contractor support for developing terminal software where the technical requirements exceed FAA in-house development capabilities. New and modified equipment will maintain or improve safety levels while increasing traffic capacity.
Standard Terminal Automation Replacement System (STARS)	A-04	Terminal	This program reflects the long-term approach to improving the FAA's automation capabilities in the terminal environment. STARS will deploy a new automation system that uses a modern, commercially-open architecture that solves current capacity problems and supports future demands.
Traffic Management System (TMS)	A-05	Airport, Terminal, En Route, Oceanic	This program develops and deploys integrated hardware and soft ware to accommodate modern computing and communications technology and provides an open-systems architecture for future functions. TMS will also develop and deploy collaborative decision-making and decision support tools for resolving NAS congestion. This program, also referred to as the Air Traffic Management (ATM) Program, will maximize air traffic throughput, minimize air traffic delays, and establish a reliable, serviceable automation platform.
En Route Software Development	A-06	En Route/Oceanic	The program provides the necessary support for the continuing development, integration, and implementation of NAS en route software changes to correct operational problems and provide systems enhancement.
Flight Service Automation System (FSAS)	A-07	Flight Service Stations	The FSAS replaces the FSAS model 1-full capacity (M1FC) and integrates M1FC functions with the integrated graphic weather display system (IGWDS) and the direct user access terminal system (DUATS). This will provide a flight service specialist with automated advancements that improve weather and Notice to Airmen (NOTAM) briefings and simplify flight plan filing.
Oceanic Automation Program (OAP)	A-10	Flight Service Stations, En Route/Oceanic	The OAP will provide an automation infrastructure including oceanic flight data processing, a computer-generated situation display, and a strategic conflict probe for alerting controllers to potential conflicts hours before they occur. Ultimately, controllers will be able to grant more fuel-efficient flexible routes, which will significantly reduce fuel costs and delays.
Oceanic Air Traffic Automation	021-140	En Route, R,E&D	This project aims to increase oceanic air traffic capacity and efficiency without degrading safety. Research and development in this project will lay the foundation for new F&E initiatives leading to the introduction of free flight in oceanic airspace.

Table 6-5. (continued)

Decision Support System Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Center Terminal Radar Approach Control (TRACON) Automation System (CTAS) Prototype	F-01, A-05	Airport, Terminal	This program develops the prototype of the center terminal radar approach control facility automation system (CTAS). CTAS provides operational prototypes of the traffic management advisor (TMA) and final approach spacing tool (FAST) at air route traffic control center (ARTCC) and TRACON pairs.
Advanced Traffic Management System (ATMS)	021-110	Flight Service, Airport, Terminal, En Route	The ATMS has been reconstructed to focus on building collaborative decision making and decision support tools that will allow FAA traffic flow managers to work cooperatively with industry in responding to NAS congestion conditions.
Surface Movement Advisor (SMA)	021-200	Airport	The SMA will interface with and improve other NAS management systems and coordinate surface activities with ATC, the airlines, and airport operators through an unprecedented sharing of operationally-critical surface movement information.
Traffic Alert and Collision (TCAS)	022-110	Aircraft/Aircrew, Terminal, En Route	This project will develop and assist in implementing an independent airborne collision avoidance capability. TCAS will reduce midair collision risks and increase capacity by aiding simultaneous approaches to parallel runways and pilot-maintained in-trail spacing via the improved cockpit display capability.
Aviation System Capacity Planning	024-110	Airport, Terminal, En Route	The program supports development of an overall capacity strategy; the conduct, measurement, and assessment of airports and technologies; and development and application of electronic tools that aid in the formulation of that strategy to reduce delays, increase the number of operations per hour and to decrease maintenance and operating costs.
Airport Pavement Technology	051-120	Airport, R,E&D	Specific projects will be carried out to develop an integrated method for pavement design that will reduce pavement design and construction costs, minimize pavement failures, lower the costs of maintenance, and reduce pavement downtime and aircraft delay costs. The program will also develop a new pavement design procedure based on layered-elastic theory to support U.S. aircraft manufacturer's efforts to introduce new aircraft.
Airborne Information for Lateral Spacing (AILS)	NASA	Airport, Aircraft/Aircrew	AILS's goal is to enable "airborne technology assisted approaches" to safely reduce lateral spacing requirements during IMC. It will provide crew with information on nearby traffic comparable to that available in VMC.

APPENDIX A: AVIATION STATISTICS

It is important to note that Denver International Airport replaced Denver Stapleton International in 1995. Therefore, the data for 1994 and 1995 reflects the enplanements and operations for Denver Stapleton International.

Table A-1. Airport Operations and Enplanements, 1994, 1995, and 1996[1]

City-Airport	Airport ID	Rank	Enplanements FY94	Enplanements FY95	Enplanements FY96	Operations FY94	Operations FY95	Operations FY96
Chicago O'Hare Int'l Airport	ORD	1	30,920,837	31,611,635	32,174,494	883,480	892,330	909,186
Hartsfield Atlanta Int'l Airport	ATL	2	25,466,184	27,349,930	30,651,427	699,400	747,105	772,597
Los Angeles Int'l Airport	LAX	3	24,932,412	26,146,785	28,247,301	687,627	716,293	764,002
Dallas-Fort Worth Int'l Airport	DFW	4	25,784,347	26,947,281	27,361,201	831,135	873,510	869,831
San Francisco Int'l Airport	SFO	5	16,396,063	16,887,347	18,325,018	430,380	436,907	442,281
Miami Int'l Airport	MIA	6	14,437,381	15,722,329	16,077,377	550,194	576,609	546,487
Denver Int'l Airport	DEN	7	15,768,233	14,979,616	15,237,496	546,305	487,225	454,234
New York John F. Kennedy Int'l Airport	JFK	8	14,059,556	14,332,130	15,003,739	352,494	345,263	360,511
Detroit Metropolitan Airport	DTW	9	12,801,476	13,990,302	14,967,807	479,738	498,887	531,098
Phoenix Sky Harbor Int'l Airport	PHX	10	12,398,247	13,517,238	14,577,015	507,698	522,634	544,363
Las Vegas McCarran Int'l Airport	LAS	11	12,183,593	13,019,859	14,295,208	488,347	508,077	479,625
Newark Int'l Airport	EWR	12	13,910,543	13,446,484	14,204,288	441,997	428,703	443,431
Lambert St. Louis Int'l Airport	STL	13	11,119,554	12,714,579	13,496,561	466,639	516,021	517,352
Minneapolis-St. Paul Int'l Airport	MSP	14	11,370,792	12,301,110	13,382,706	454,441	466,916	483,570
Boston Logan Int'l Airport	BOS	15	12,071,084	11,954,568	12,250,552	478,660	478,253	462,507
George Bush Intercontinental Airport	IAH	16	10,257,228	11,494,226	11,912,957	352,385	375,246	391,939
Orlando Int'l Airport	MCO	17	10,453,014	10,584,116	11,791,816	344,213	343,609	341,942
Seattle-Tacoma Int'l Airport	SEA	18	10,216,020	11,188,640	11,741,706	345,052	382,100	397,591
Honolulu Int'l Airport	HNL	19	11,076,779	11,072,604	11,264,391	357,116	376,224	374,965
Charlotte/Douglas Int'l Airport	CLT	20	10,025,080	10,473,627	10,725,530	471,128	474,338	457,054
New York LaGuardia Airport	LGA	21	10,244,717	10,387,115	10,323,763	335,539	346,869	342,618
Greater Pittsburgh Int'l Airport	PIT	22	9,817,880	9,986,599	10,108,915	435,433	452,900	447,436
Salt Lake City Int'l Airport	SLC	23	8,190,014	8,662,126	9,813,187	343,807	349,699	373,815
Philadelphia Int'l Airport	PHL	24	8,447,261	8,849,175	9,073,360	402,845	409,148	406,121
Greater Cincinnati Int'l Airport	CVG	25	6,614,065	7,095,874	8,782,063	333,832	358,203	393,523
Washington National Airport	DCA	26	7,494,656	7,380,226	7,227,361	316,790	316,404	309,754
San Diego Int'l Lindberg Field	SAN	27	6,295,539	6,626,050	6,841,862	215,215	228,740	243,595
Baltimore-Washington Int'l Airport	BWI	28	6,119,984	6,595,515	6,554,638	286,392	296,932	270,156
Tampa Int'l Airport	TPA	29	5,926,142	5,675,105	6,229,896	263,541	261,617	272,782
Portland Int'l Airport	PDX	30	4,792,017	5,454,342	6,060,665	277,000	301,785	305,964
Washington Dulles Int'l Airport	IAD	31	5,600,138	5,713,037	6,039,746	296,201	311,279	330,439
Cleveland Hopkins Int'l Airport	CLE	32	5,076,463	5,333,077	5,429,955	260,485	268,097	291,029
Fort Lauderdale Int'l Airport	FLL	33	5,074,130	4,679,592	5,191,494	233,044	238,108	236,342
San Juan Int'l Airport	SJU	34	4,939,263	5,050,689	5,025,689	174,598	183,082	186,273
Kansas City Int'l Airport	MCI	35	4,357,995	4,692,493	4,971,749	198,274	207,518	196,405
Metropolitan Oakland Int'l Airport	OAK	36	3,884,422	4,720,940	4,809,148	470,901	502,952	516,498
San Jose Int'l Airport	SJC	37	3,985,712	4,335,906	4,778,998	298,220	270,519	278,941
Memphis Int'l Airport	MEM	38	3,896,277	4,215,624	4,579,094	345,534	356,294	363,945
Chicago Midway Airport	MDW	39	4,046,580	4,278,735	4,476,761	254,570	268,575	254,351
New Orleans Int'l Airport	MSY	40	3,885,030	4,133,169	4,186,698	167,375	177,383	163,210
Houston William P. Hobby Airport	HOU	41	3,914,188	3,925,461	3,965,391	236,683	245,603	252,254
Santa Ana John Wayne Airport	SNA	42	3,252,526	3,521,360	3,577,067	509,220	493,391	474,976

1. At the top 100 airports, ranked by 1996 enplanements.

Table A-1. Airport Operations and Enplanements, 1994, 1995, and 1996[1]

City-Airport	Airport ID	Rank	Enplanements FY94	Enplanements FY95	Enplanements FY96	Operations FY94	Operations FY95	Operations FY96
Dallas-Love Field	DAL	43	3,381,024	3,418,261	3,505,076	217,331	208,768	220,651
Indianapolis Int'l Airport	IND	44	3,081,854	3,170,445	3,477,759	237,937	245,541	235,940
Sacramento Int'l Airport	SMF	45	2,829,433	3,308,376	3,460,728	149,053	177,010	174,117
Nashville Int'l Airport	BNA	46	4,200,995	3,915,839	3,433,435	295,558	278,957	226,274
San Antonio Int'l Airport	SAT	47	2,963,038	3,066,256	3,283,997	238,277	238,315	258,265
Albuquerque Int'l Airport	ABQ	48	2,997,170	3,079,572	3,235,874	220,914	199,114	202,254
Ontario Int'l Airport	ONT	49	3,224,834	3,234,261	3,188,397	158,635	158,302	153,924
Port Columbus Int'l Airport	CMH	50	2,778,074	2,805,286	3,133,068	223,633	204,100	211,434
Raleigh-Durham Int'l Airport	RDU	51	4,612,034	3,216,256	3,096,367	283,713	214,011	227,816
Reno Cannon Int'l Airport	RNO	52	2,541,173	2,691,092	3,042,339	161,190	151,603	154,234
Austin Municipal Airport	AUS	53	2,462,833	2,652,309	2,808,852	192,040	201,409	215,055
Palm Beach Int'l Airport	PBI	54	2,721,921	2,687,516	2,804,201	216,480	205,104	202,875
Kahului Airport	OGG	55	2,627,961	2,763,401	2,801,737	176,209	178,602	183,046
Bradley Int'l Airport	BDL	56	2,351,391	2,519,357	2,667,513	163,180	176,382	160,752
Milwaukee Int'l Airport	MKE	57	2,459,175	2,527,447	2,662,988	213,602	209,939	199,584
Burbank-Glendale-Pasadena Airport	BUR	58	2,372,003	2,471,234	2,464,662	194,264	184,366	184,843
Colorado Springs Municipal Airport	COS	59	793,546	1,125,562	2,316,084	239,885	206,192	227,201
Fort Myers Regional Airport	RSW	60	1,938,706	1,989,677	2,088,515	64,849	67,026	71,231
Anchorage Int'l Airport	ANC	61	2,079,106	2,104,169	1,894,953	215,641	217,768	283,611
Guam Int'l	GUM	62	1,186,577	1,407,688	1,838,771	68,912	59,928	61,156
Jacksonville Int'l Airport	JAX	63	1,886,666	1,816,518	1,823,174	142,821	142,786	136,725
El Paso Int'l Airport	ELP	64	1,815,826	1,861,059	1,808,991	157,984	151,905	140,226
Louisville Int'l Airport	SDF	65	1,537,249	1,787,115	1,764,275	179,921	178,646	173,152
Tucson Int'l Airport	TUS	66	1,561,999	1,713,680	1,753,331	249,729	238,024	245,929
Oklahoma City World Airport	OKC	67	1,614,178	1,680,562	1,733,087	146,759	149,275	151,828
Omaha Eppley Airfield	OMA	68	1,171,790	1,462,172	1,710,151	154,154	160,039	159,974
Tulsa Int'l Airport	TUL	69	1,523,862	1,576,745	1,647,923	198,332	186,512	199,383
Spokane Int'l Airport	GEG	70	1,351,492	1,494,645	1,631,997	122,615	119,701	114,767
Greater Buffalo Int'l Airport	BUF	71	1,800,052	1,628,842	1,551,792	145,221	153,646	148,404
Greensboro Int'l Airport	GSO	72	1,766,208	1,846,943	1,448,177	157,401	173,259	143,661
Norfolk Int'l Airport	ORF	73	1,682,705	1,423,899	1,372,199	141,861	135,793	139,079
Birmingham Airport	BHM	74	1,093,971	1,229,411	1,351,333	161,638	165,295	160,728
Little Rock Adams Field	LIT	75	1,204,474	1,273,827	1,269,245	173,126	169,312	163,341
Boise Air Terminal	BOI	76	924,648	1,063,795	1,253,019	163,306	166,499	179,843
Lihue Airport	LIH	77	1,115,834	1,160,951	1,233,555	92,542	94,439	104,782
Greater Rochester Int'l Airport	ROC	78	1,296,388	1,249,038	1,213,888	189,372	190,053	177,267
Kailua-Kona Keahole	KOA	79	1,115,875	1,146,240	1,203,305	66,821	72,057	73,110
Providence Green State Airport	PVD	80	1,199,822	1,122,944	1,078,836	123,195	133,679	119,355
Richmond Int'l Airport	RIC	81	1,101,461	1,096,129	1,078,592	153,589	153,119	146,105
Albany County Airport	ALB	82	1,098,976	1,055,983	1,003,412	158,658	150,986	132,928
Syracuse Hancock Int'l Airport	SYR	83	1,079,073	1,026,957	994,271	158,677	153,066	145,512
Dayton Int'l Airport	DAY	84	1,238,248	1,174,318	991,908	154,481	151,248	148,343

1. At the top 100 airports, ranked by 1996 enplanements.

Table A-1. Airport Operations and Enplanements, 1994, 1995, and 1996[1]

City-Airport	Airport ID	Rank	Enplanements FY94	Enplanements FY95	Enplanements FY96	Operations FY94	Operations FY95	Operations FY96
Des Moines Int'l Airport	DSM	85	691,307	740,458	917,160	133,954	137,043	137,698
Grand Rapids Int'l Airport	GRR	86	773,966	801,531	837,568	154,264	151,742	138,020
Sarasota Bradenton Airport	SRQ	87	862,662	783,290	791,734	147,115	145,886	154,833
Hilo Int'l Airport	ITO	88	702,798	717,226	760,001	90,802	81,497	90,024
Wichita Mid-Continent Airport	ICT	89	564,091	613,569	734,820	167,757	177,982	182,186
Charleston AFB Int'l Airport	CHS	90	859,131	750,803	706,168	151,674	137,517	145,025
Greer Greenville-Spartanburg Airport	GSP	91	713,752	704,493	691,467	62,526	58,978	59,371
Knoxville McGhee-Tyson Airport	TYS	92	654,899	663,253	689,864	128,032	136,507	131,598
Lubbock Int'l Airport	LBB	93	610,220	594,641	605,724	104,968	101,944	95,150
Savannah Int'l Airport	SAV	94	553,897	567,705	599,210	97,509	95,060	95,472
Harrisburg Int'l Airport	MDT	95	684,571	658,083	595,720	82,405	83,447	78,161
Columbia Metropolitan Airport	CAE	96	561,241	596,761	568,892	108,410	106,544	107,107
Portland Int'l Jetport	PWM	97	584,601	562,556	564,580	114,162	120,234	115,032
Islip Long Island Mac Arthur Airport	ISP	98	601,451	565,521	560,144	189,663	188,314	175,750
Dane County Regional	MSN	99	525,139	519,563	550,283	156,712	150,458	154,707
Palm Springs Regional Airport	PSP	100	479,779	457,423	549,218	92,233	102,072	93,584

Totals:

1994 Enplanements 525,710,572
1995 Enplanements 546,389,269
1996 Enplanements 574,580,420
1994 Operations 26,129,620
1995 Operations 26,438,349
1996 Operations 26,567,416

1. At the top 100 airports, ranked by 1996 enplanements.

Table A-2. Airport Enplanements, 1996 and Forecast 2011[2]

City-Airport	Airport ID	Rank	Enplanements FY96	Enplanements FY2011	% Growth
Chicago O'Hare Int'l Airport	ORD	1	32,174,494	49,147,000	52.8
Hartsfield Atlanta Int'l Airport	ATL	2	30,651,427	45,283,000	47.7
Los Angeles Int'l Airport	LAX	3	28,247,301	47,077,000	66.7
Dallas-Fort Worth Int'l Airport	DFW	4	27,361,201	49,750,000	81.8
San Francisco Int'l Airport	SFO	5	18,325,018	31,482,000	71.8
Miami Int'l Airport	MIA	6	16,077,377	31,675,000	97.0
Denver Int'l Airport	DEN	7	15,237,496	22,516,000	47.8
New York John F. Kennedy Int'l Airport	JFK	8	15,003,739	22,832,000	52.2
Detroit Metropolitan Airport	DTW	9	14,967,807	28,324,000	89.2
Phoenix Sky Harbor Int'l Airport	PHX	10	14,577,015	15,994,000	9.7
Las Vegas McCarran Int'l Airport	LAS	11	14,295,208	30,512,000	113.4
Newark Int'l Airport	EWR	12	14,204,288	23,089,000	62.5
Lambert St. Louis Int'l Airport	STL	13	13,496,561	23,054,000	70.8
Minneapolis-St. Paul Int'l Airport	MSP	14	13,382,706	23,579,000	76.2
Boston Logan Int'l Airport	BOS	15	12,250,552	17,181,000	40.2
George Bush Intercontinental Airport	IAH	16	11,912,957	22,926,000	92.4
Orlando Int'l Airport	MCO	17	11,791,816	26,609,000	125.7
Seattle-Tacoma Int'l Airport	SEA	18	11,741,706	19,554,000	66.5
Honolulu Int'l Airport	HNL	19	11,264,391	18,271,000	62.2
Charlotte/Douglas Int'l Airport	CLT	20	10,725,530	17,401,000	62.2
New York LaGuardia Airport	LGA	21	10,323,763	15,080,000	46.1
Greater Pittsburgh Int'l Airport	PIT	22	10,108,915	27,810,000	175.1
Salt Lake City Int'l Airport	SLC	23	9,813,187	17,622,000	79.6
Philadelphia Int'l Airport	PHL	24	9,073,360	16,762,000	84.7
Greater Cincinnati Int'l Airport	CVG	25	8,782,063	19,932,000	127.0
Washington National Airport	DCA	26	7,227,361	9,207,000	27.4
San Diego Int'l Lindberg Field	SAN	27	6,841,862	11,729,000	71.4
Baltimore-Washington Int'l Airport	BWI	28	6,554,638	11,698,000	78.5
Tampa Int'l Airport	TPA	29	6,229,896	10,310,000	65.5
Portland Int'l Airport	PDX	30	6,060,665	11,730,000	93.5
Washington Dulles Int'l Airport	IAD	31	6,039,746	11,087,000	83.6
Cleveland Hopkins Int'l Airport	CLE	32	5,429,955	9,755,000	79.7
Fort Lauderdale Int'l Airport	FLL	33	5,191,494	10,867,000	109.3
San Juan Int'l Airport	SJU	34	5,025,689	8,084,000	60.9
Kansas City Int'l Airport	MCI	35	4,971,749	7,847,000	57.8
Metropolitan Oakland Int'l Airport	OAK	36	4,809,148	8,902,000	85.1
San Jose Int'l Airport	SJC	37	4,778,998	9,166,000	91.8
Memphis Int'l Airport	MEM	38	4,579,094	7,918,000	72.9
Chicago Midway Airport	MDW	39	4,476,761	7,671,000	71.4
New Orleans Int'l Airport	MSY	40	4,186,698	6,567,000	56.9
Houston William P. Hobby Airport	HOU	41	3,965,391	5,816,000	46.7
Santa Ana John Wayne Airport	SNA	42	3,577,067	7,428,000	107.7

2. At the top 100 airports, ranked by 1996 enplanements.

Table A-2. Airport Enplanements, 1996 and Forecast 2011[2]

City-Airport	Airport ID	Rank	Enplanements FY96	Enplanements FY2011	% Growth
Dallas-Love Field	DAL	43	3,505,076	5,909,000	68.6
Indianapolis Int'l Airport	IND	44	3,477,759	6,620,000	90.4
Sacramento Int'l Airport	SMF	45	3,460,728	6,554,000	89.4
Nashville Int'l Airport	BNA	46	3,433,435	7,145,000	108.1
San Antonio Int'l Airport	SAT	47	3,283,997	6,351,000	93.4
Albuquerque Int'l Airport	ABQ	48	3,235,874	5,850,000	80.8
Ontario Int'l Airport	ONT	49	3,188,397	5,181,000	62.5
Port Columbus Int'l Airport	CMH	50	3,133,068	6,094,000	94.5
Raleigh-Durham Int'l Airport	RDU	51	3,096,367	5,637,000	82.1
Reno Cannon Int'l Airport	RNO	52	3,042,339	6,292,000	106.8
Austin Municipal Airport	AUS	53	2,808,852	5,204,000	85.3
Palm Beach Int'l Airport	PBI	54	2,804,201	4,289,000	52.9
Kahului Airport	OGG	55	2,801,737	5,057,000	80.5
Bradley Int'l Airport	BDL	56	2,667,513	4,803,000	80.1
Milwaukee Int'l Airport	MKE	57	2,662,988	4,983,000	87.1
Burbank-Glendale-Pasadena Airport	BUR	58	2,464,662	4,997,000	102.7
Colorado Springs Municipal Airport	COS	59	2,316,084	4,264,000	84.1
Fort Myers Regional Airport	RSW	60	2,088,515	4,724,000	126.2
Anchorage Int'l Airport	ANC	61	1,894,953	3,476,000	83.4
Guam Int'l	GUM	62	1,838,771	3,713,000	101.9
Jacksonville Int'l Airport	JAX	63	1,823,174	3,544,000	94.4
El Paso Int'l Airport	ELP	64	1,808,991	3,461,000	91.3
Louisville Int'l Airport	SDF	65	1,764,275	3,270,000	85.3
Tucson Int'l Airport	TUS	66	1,753,331	3,624,000	106.7
Oklahoma City World Airport	OKC	67	1,733,087	3,645,000	110.3
Omaha Eppley Airfield	OMA	68	1,710,151	2,989,000	74.8
Tulsa Int'l Airport	TUL	69	1,647,923	3,549,000	115.4
Spokane Int'l Airport	GEG	70	1,631,997	3,388,000	107.6
Greater Buffalo Int'l Airport	BUF	71	1,551,792	2,259,000	45.6
Greensboro Int'l Airport	GSO	72	1,448,177	2,866,000	97.9
Norfolk Int'l Airport	ORF	73	1,372,199	2,585,000	88.4
Birmingham Airport	BHM	74	1,351,333	2,510,000	85.7
Little Rock Adams Field	LIT	75	1,269,245	2,560,000	101.7
Boise Air Terminal	BOI	76	1,253,019	2,361,000	88.4
Lihue Airport	LIH	77	1,233,555	2,103,000	70.5
Greater Rochester Int'l Airport	ROC	78	1,213,888	2,273,000	87.2
Kailua-Kona Keahole	KOA	79	1,203,305	2,483,000	106.3
Providence Green State Airport	PVD	80	1,078,836	2,239,000	107.5
Richmond Int'l Airport	RIC	81	1,078,592	1,875,000	73.8
Albany County Airport	ALB	82	1,003,412	1,785,000	77.9
Syracuse Hancock Int'l Airport	SYR	83	994,271	1,354,000	36.2

2. At the top 100 airports, ranked by 1996 enplanements.

Table A-2. Airport Enplanements, 1996 and Forecast 2011[2]

City-Airport	Airport ID	Rank	Enplanements FY96	Enplanements FY2011	% Growth
Dayton Int'l Airport	DAY	84	991,908	1,066,000	7.5
Des Moines Int'l Airport	DSM	85	917,160	1,674,000	82.5
Grand Rapids Int'l Airport	GRR	86	837,568	1,533,000	83.0
Sarasota Bradenton Airport	SRQ	87	791,734	1,574,000	98.8
Hilo Int'l Airport	ITO	88	760,001	1,304,000	71.6
Wichita Mid-Continent Airport	ICT	89	734,820	973,000	32.4
Charleston AFB Int'l Airport	CHS	90	706,168	1,302,000	84.4
Greer Greenville-Spartanburg Airport	GSP	91	691,467	1,288,000	86.3
Knoxville McGhee-Tyson Airport	TYS	92	689,864	1,313,000	90.3
Lubbock Int'l Airport	LBB	93	605,724	824,000	36.0
Savannah Int'l Airport	SAV	94	599,210	1,060,000	76.9
Harrisburg Int'l Airport	MDT	95	595,720	860,000	44.4
Columbia Metropolitan Airport	CAE	96	568,892	749,000	31.7
Portland Int'l Jetport	PWM	97	564,580	749,000	32.7
Islip Long Island Mac Arthur Airport	ISP	98	560,144	1,065,000	90.1
Dane County Regional	MSN	99	550,283	772,000	40.3
Palm Springs Regional Airport	PSP	100	549,218	1,090,000	98.5

Totals:

1996 Enplanements 574,580,420

2011 Enplanements 1,002,306,000

Average forecast growth at the top 100 airports for the 15 year period 78.6

2. At the top 100 airports, ranked by 1996 enplanements.

Table A-3. Total Airport Operations, 1996 and Forecast 2011[3]

City-Airport	Airport ID	Rank	Operations FY96	FY2011	% Growth
Chicago O'Hare Int'l Airport	ORD	1	909,186	1,105,000	21.5
Dallas-Fort Worth Int'l Airport	DFW	2	869,831	1,368,000	57.3
Hartsfield Atlanta Int'l Airport	ATL	3	772,597	972,000	25.8
Los Angeles Int'l Airport	LAX	4	764,002	1,019,000	33.4
Miami Int'l Airport	MIA	5	546,487	762,000	39.4
Phoenix Sky Harbor Int'l Airport	PHX	6	544,363	581,000	6.7
Detroit Metropolitan Airport	DTW	7	531,098	775,000	45.9
Lambert St. Louis Int'l Airport	STL	8	517,352	688,000	33.0
Metropolitan Oakland Int'l Airport	OAK	9	516,498	612,000	18.5
Minneapolis-St. Paul Int'l Airport	MSP	10	483,570	672,000	39.0
Las Vegas McCarran Int'l Airport	LAS	11	479,625	742,000	54.7
Santa Ana John Wayne Airport	SNA	12	474,976	615,000	29.5
Boston Logan Int'l Airport	BOS	13	462,507	523,000	13.1
Charlotte/Douglas Int'l Airport	CLT	14	457,054	603,000	31.9
Denver Int'l Airport	DEN	15	454,234	590,000	29.9
Greater Pittsburgh Int'l Airport	PIT	16	447,436	773,000	72.8
Newark Int'l Airport	EWR	17	443,431	601,000	35.5
San Francisco Int'l Airport	SFO	18	442,281	628,000	42.0
Philadelphia Int'l Airport	PHL	19	406,121	544,000	34.0
Seattle-Tacoma Int'l Airport	SEA	20	397,591	543,000	36.6
Greater Cincinnati Int'l Airport	CVG	21	393,523	695,000	76.6
George Bush Intercontinental Airport	IAH	22	391,939	631,000	61.0
Honolulu Int'l Airport	HNL	23	374,965	501,000	33.6
Salt Lake City Int'l Airport	SLC	24	373,815	540,000	44.5
Memphis Int'l Airport	MEM	25	363,945	552,000	51.7
New York John F. Kennedy Int'l Airport	JFK	26	360,511	426,000	18.2
New York LaGuardia Airport	LGA	27	342,618	394,000	15.0
Orlando Int'l Airport	MCO	28	341,942	572,000	67.3
Washington Dulles Int'l Airport	IAD	29	330,439	430,000	30.1
Washington National Airport	DCA	30	309,754	327,000	5.6
Portland Int'l Airport	PDX	31	305,964	434,000	41.8
Cleveland Hopkins Int'l Airport	CLE	32	291,029	407,000	39.8
Anchorage Int'l Airport	ANC	33	283,611	392,000	38.2
San Jose Int'l Airport	SJC	34	278,941	344,000	23.3
Tampa Int'l Airport	TPA	35	272,782	360,000	32.0
Baltimore-Washington Int'l Airport	BWI	36	270,156	377,000	39.5
San Antonio Int'l Airport	SAT	37	258,265	335,000	29.7
Chicago Midway Airport	MDW	38	254,351	326,000	28.2
Houston William P. Hobby Airport	HOU	39	252,254	300,000	18.9
Tucson Int'l Airport	TUS	40	245,929	271,000	10.2
San Diego Int'l Lindberg Field	SAN	41	243,595	342,000	40.4
Fort Lauderdale Int'l Airport	FLL	42	236,342	330,000	39.6

3. At the top 100 airports, ranked by 1996 operations.

Table A-3. Total Airport Operations, 1996 and Forecast 2011[3]

City-Airport	Airport ID	Rank	Operations FY96	Operations FY2011	% Growth
Indianapolis Int'l Airport	IND	43	235,940	339,000	43.7
Raleigh-Durham Int'l Airport	RDU	44	227,816	279,000	22.5
Colorado Springs Municipal Airport	COS	45	227,201	296,000	30.3
Nashville Int'l Airport	BNA	46	226,274	308,000	36.1
Dallas-Love Field	DAL	47	220,651	282,000	27.8
Austin Municipal Airport	AUS	48	215,055	276,000	28.3
Port Columbus Int'l Airport	CMH	49	211,434	277,000	31.0
Palm Beach Int'l Airport	PBI	50	202,875	221,000	8.9
Albuquerque Int'l Airport	ABQ	51	202,254	262,000	29.5
Milwaukee Int'l Airport	MKE	52	199,584	266,000	33.3
Tulsa Int'l Airport	TUL	53	199,383	245,000	22.9
Kansas City Int'l Airport	MCI	54	196,405	262,000	33.4
San Juan Int'l Airport	SJU	55	186,273	232,000	24.5
Burbank-Glendale-Pasadena Airport	BUR	56	184,843	243,000	31.5
Kahului Airport	OGG	57	183,046	234,000	27.8
Wichita Mid-Continent Airport	ICT	58	182,186	207,000	13.6
Boise Air Terminal	BOI	59	179,843	233,000	29.6
Greater Rochester Int'l Airport	ROC	60	177,267	219,000	23.5
Islip Long Island Mac Arthur Airport	ISP	61	175,750	177,000	0.7
Sacramento Int'l Airport	SMF	62	174,117	247,000	41.9
Louisville Int'l Airport	SDF	63	173,152	231,000	33.4
Little Rock Adams Field	LIT	64	163,341	191,000	16.9
New Orleans Int'l Airport	MSY	65	163,210	201,000	23.2
Bradley Int'l Airport	BDL	66	160,752	204,000	26.9
Birmingham Airport	BHM	67	160,728	186,000	15.7
Omaha Eppley Airfield	OMA	68	159,974	216,000	35.0
Sarasota Bradenton Airport	SRQ	69	154,833	184,000	18.8
Dane County Regional	MSN	70	154,707	169,000	9.2
Reno Cannon Int'l Airport	RNO	71	154,234	210,000	36.2
Ontario Int'l Airport	ONT	72	153,924	193,000	25.4
Oklahoma City World Airport	OKC	73	151,828	167,000	10.0
Greater Buffalo Int'l Airport	BUF	74	148,404	180,000	21.3
Dayton Int'l Airport	DAY	75	148,343	174,000	17.3
Richmond Int'l Airport	RIC	76	146,105	177,000	21.1
Syracuse Hancock Int'l Airport	SYR	77	145,512	188,000	29.2
Charleston AFB Int'l Airport	CHS	78	145,025	155,000	6.9
Greensboro Int'l Airport	GSO	79	143,661	183,000	27.4
El Paso Int'l Airport	ELP	80	140,226	164,000	17.0
Norfolk Int'l Airport	ORF	81	139,079	167,000	20.1
Grand Rapids Int'l Airport	GRR	82	138,020	175,000	26.8
Des Moines Int'l Airport	DSM	83	137,698	156,000	13.3
Jacksonville Int'l Airport	JAX	84	136,725	181,000	32.4

3. At the top 100 airports, ranked by 1996 operations.

Table A-3. Total Airport Operations, 1996 and Forecast 2011[3]

City-Airport	Airport ID	Rank	Operations FY96	FY2011	% Growth
Albany County Airport	ALB	85	132,928	176,000	32.4
Knoxville McGhee-Tyson Airport	TYS	86	131,598	160,000	21.6
Providence Green State Airport	PVD	87	119,355	156,000	30.7
Portland Int'l Jetport	PWM	88	115,032	130,000	13.0
Spokane Int'l Airport	GEG	89	114,767	163,000	42.0
Columbia Metropolitan Airport	CAE	90	107,107	112,000	4.6
Lihue Airport	LIH	91	104,782	152,000	45.1
Savannah Int'l Airport	SAV	92	95,472	104,000	8.9
Lubbock Int'l Airport	LBB	93	95,150	92,000	-3.3
Palm Springs Regional Airport	PSP	94	93,584	106,000	13.3
Hilo Int'l Airport	ITO	95	90,024	111,000	23.3
Harrisburg Int'l Airport	MDT	96	78,161	81,000	3.6
Kailua-Kona Keahole	KOA	97	73,110	99,000	35.4
Fort Myers Regional Airport	RSW	98	71,231	130,000	82.5
Guam Int'l	GUM	99	61,156	73,000	19.4
Greer Greenville-Spartanburg Airport	GSP	100	59,371	74,000	24.6

Totals:

1996 Operations 26,567,416
2011 Operations 35,078,000
Average forecast growth at the top 100 airports for the 15 year period 29.1

3. At the top 100 airports, ranked by 1996 operations.

Table A-4. Growth in Enplanements From 1995 to 1996[4]

City-Airport	Airport ID	Rank	Enplanements FY95	Enplanements FY96	% Growth
Colorado Springs Municipal Airport	COS	1	1,125,562	2,316,084	105.8
Guam Int'l	GUM	2	1,407,688	1,838,771	30.6
Des Moines Int'l Airport	DSM	3	740,458	917,160	23.9
Greater Cincinnati Int'l Airport	CVG	4	7,095,874	8,782,063	23.8
Palm Springs Regional Airport	PSP	5	457,423	549,218	20.1
Wichita Mid-Continent Airport	ICT	6	613,569	734,820	19.8
Boise Air Terminal	BOI	7	1,063,795	1,253,019	17.8
Omaha Eppley Airfield	OMA	8	1,462,172	1,710,151	17.0
Salt Lake City Int'l Airport	SLC	9	8,662,126	9,813,187	13.3
Reno Cannon Int'l Airport	RNO	10	2,691,092	3,042,339	13.1
Hartsfield Atlanta Int'l Airport	ATL	11	27,349,930	30,651,427	12.1
Port Columbus Int'l Airport	CMH	12	2,805,286	3,133,068	11.7
Orlando Int'l Airport	MCO	13	10,584,116	11,791,816	11.4
Portland Int'l Airport	PDX	14	5,454,342	6,060,665	11.1
Fort Lauderdale Int'l Airport	FLL	15	4,679,592	5,191,494	10.9
San Jose Int'l Airport	SJC	16	4,335,906	4,778,998	10.2
Birmingham Airport	BHM	17	1,229,411	1,351,333	9.9
Las Vegas McCarran Int'l Airport	LAS	18	13,019,859	14,295,208	9.8
Tampa Int'l Airport	TPA	19	5,675,105	6,229,896	9.8
Indianapolis Int'l Airport	IND	20	3,170,445	3,477,759	9.7
Spokane Int'l Airport	GEG	21	1,494,645	1,631,997	9.2
Minneapolis-St. Paul Int'l Airport	MSP	22	12,301,110	13,382,706	8.8
Memphis Int'l Airport	MEM	23	4,215,624	4,579,094	8.6
San Francisco Int'l Airport	SFO	24	16,887,347	18,325,018	8.5
Los Angeles Int'l Airport	LAX	25	26,146,785	28,247,301	8.0
Phoenix Sky Harbor Int'l Airport	PHX	26	13,517,238	14,577,015	7.8
San Antonio Int'l Airport	SAT	27	3,066,256	3,283,997	7.1
Detroit Metropolitan Airport	DTW	28	13,990,302	14,967,807	7.0
Lihue Airport	LIH	29	1,160,951	1,233,555	6.3
Lambert St. Louis Int'l Airport	STL	30	12,714,579	13,496,561	6.2
Hilo Int'l Airport	ITO	31	717,226	760,001	6.0
Kansas City Int'l Airport	MCI	32	4,692,493	4,971,749	6.0
Dane County Regional	MSN	33	519,563	550,283	5.9
Austin Municipal Airport	AUS	34	2,652,309	2,808,852	5.9
Bradley Int'l Airport	BDL	35	2,519,357	2,667,513	5.9
Washington Dulles Int'l Airport	IAD	36	5,713,037	6,039,746	5.7
Newark Int'l Airport	EWR	37	13,446,484	14,204,288	5.6
Savannah Int'l Airport	SAV	38	567,705	599,210	5.5
Milwaukee Int'l Airport	MKE	39	2,527,447	2,662,988	5.4
Albuquerque Int'l Airport	ABQ	40	3,079,572	3,235,874	5.1
Kailua-Kona Keahole	KOA	41	1,146,240	1,203,305	5.0
Fort Myers Regional Airport	RSW	42	1,989,677	2,088,515	5.0

4. At the top 100 airports, ranked by growth in total enplanments.

Table A-4. Growth in Enplanements From 1995 to 1996[4]

City-Airport	Airport ID	Rank	Enplanements FY95	Enplanements FY96	% Growth
Seattle-Tacoma Int'l Airport	SEA	43	11,188,640	11,741,706	4.9
New York John F. Kennedy Int'l Airport	JFK	44	14,332,130	15,003,739	4.7
Chicago Midway Airport	MDW	45	4,278,735	4,476,761	4.6
Sacramento Int'l Airport	SMF	46	3,308,376	3,460,728	4.6
Tulsa Int'l Airport	TUL	47	1,576,745	1,647,923	4.5
Grand Rapids Int'l Airport	GRR	48	801,531	837,568	4.5
Palm Beach Int'l Airport	PBI	49	2,687,516	2,804,201	4.3
Knoxville McGhee-Tyson Airport	TYS	50	663,253	689,864	4.0
George Bush Intercontinental Airport	IAH	51	11,494,226	11,912,957	3.6
San Diego Int'l Lindberg Field	SAN	52	6,626,050	6,841,862	3.3
Oklahoma City World Airport	OKC	53	1,680,562	1,733,087	3.1
Dallas-Love Field	DAL	54	3,418,261	3,505,076	2.5
Philadelphia Int'l Airport	PHL	55	8,849,175	9,073,360	2.5
Boston Logan Int'l Airport	BOS	56	11,954,568	12,250,552	2.5
Charlotte/Douglas Int'l Airport	CLT	57	10,473,627	10,725,530	2.4
Tucson Int'l Airport	TUS	58	1,713,680	1,753,331	2.3
Miami Int'l Airport	MIA	59	15,722,329	16,077,377	2.3
Metropolitan Oakland Int'l Airport	OAK	60	4,720,940	4,809,148	1.9
Lubbock Int'l Airport	LBB	61	594,641	605,724	1.9
Cleveland Hopkins Int'l Airport	CLE	62	5,333,077	5,429,955	1.8
Chicago O'Hare Int'l Airport	ORD	63	31,611,635	32,174,494	1.8
Honolulu Int'l Airport	HNL	64	11,072,604	11,264,391	1.7
Denver Int'l Airport	DEN	65	14,979,616	15,237,496	1.7
Santa Ana John Wayne Airport	SNA	66	3,521,360	3,577,067	1.6
Dallas-Fort Worth Int'l Airport	DFW	67	26,947,281	27,361,201	1.5
Kahului Airport	OGG	68	2,763,401	2,801,737	1.4
New Orleans Int'l Airport	MSY	69	4,133,169	4,186,698	1.3
Greater Pittsburgh Int'l Airport	PIT	70	9,986,599	10,108,915	1.2
Sarasota Bradenton Airport	SRQ	71	783,290	791,734	1.1
Houston William P. Hobby Airport	HOU	72	3,925,461	3,965,391	1.0
Jacksonville Int'l Airport	JAX	73	1,816,518	1,823,174	0.4
Portland Int'l Jetport	PWM	74	562,556	564,580	0.4
Burbank-Glendale-Pasadena Airport	BUR	75	2,471,234	2,464,662	-0.3
Little Rock Adams Field	LIT	76	1,273,827	1,269,245	-0.4
San Juan Int'l Airport	SJU	77	5,050,689	5,025,689	-0.5
New York LaGuardia Airport	LGA	78	10,387,115	10,323,763	-0.6
Baltimore-Washington Int'l Airport	BWI	79	6,595,515	6,554,638	-0.6
Islip Long Island Mac Arthur Airport	ISP	80	565,521	560,144	-1.0
Louisville Int'l Airport	SDF	81	1,787,115	1,764,275	-1.3
Ontario Int'l Airport	ONT	82	3,234,261	3,188,397	-1.4
Richmond Int'l Airport	RIC	83	1,096,129	1,078,592	-1.6
Greer Greenville-Spartanburg Airport	GSP	84	704,493	691,467	-1.8

4. At the top 100 airports, ranked by growth in total enplanments.

Table A-4. Growth in Enplanements From 1995 to 1996[4]

City-Airport	Airport ID	Rank	Enplanements FY95	Enplanements FY96	% Growth
Washington National Airport	DCA	85	7,380,226	7,227,361	-2.1
El Paso Int'l Airport	ELP	86	1,861,059	1,808,991	-2.8
Greater Rochester Int'l Airport	ROC	87	1,249,038	1,213,888	-2.8
Syracuse Hancock Int'l Airport	SYR	88	1,026,957	994,271	-3.2
Norfolk Int'l Airport	ORF	89	1,423,899	1,372,199	-3.6
Raleigh-Durham Int'l Airport	RDU	90	3,216,256	3,096,367	-3.7
Providence Green State Airport	PVD	91	1,122,944	1,078,836	-3.9
Columbia Metropolitan Airport	CAE	92	596,761	568,892	-4.7
Greater Buffalo Int'l Airport	BUF	93	1,628,842	1,551,792	-4.7
Albany County Airport	ALB	94	1,055,983	1,003,412	-5.0
Charleston AFB Int'l Airport	CHS	95	750,803	706,168	-5.9
Harrisburg Int'l Airport	MDT	96	658,083	595,720	-9.5
Anchorage Int'l Airport	ANC	97	2,104,169	1,894,953	-9.9
Nashville Int'l Airport	BNA	98	3,915,839	3,433,435	-12.3
Dayton Int'l Airport	DAY	99	1,174,318	991,908	-15.5
Greensboro Int'l Airport	GSO	100	1,846,943	1,448,177	-21.6

Totals:

1995 Enplanements 546,389,269

1996 Enplanements 574,580,420

Average forecast growth at the top 100 airports 5.0

4. At the top 100 airports, ranked by growth in total enplanments.

Table A-5. Growth in Operations From 1995 to 1996[5]

City-Airport	Airport ID	Rank	Operations FY95	FY96	% Growth
Anchorage Int'l Airport	ANC	1	217,768	283,611	30.2
Lihue Airport	LIH	2	94,439	104,782	11.0
Hilo Int'l Airport	ITO	3	81,497	90,024	10.5
Colorado Springs Municipal Airport	COS	4	206,192	227,201	10.2
Greater Cincinnati Int'l Airport	CVG	5	358,203	393,523	9.9
Cleveland Hopkins Int'l Airport	CLE	6	268,097	291,029	8.6
San Antonio Int'l Airport	SAT	7	238,315	258,265	8.4
Boise Air Terminal	BOI	8	166,499	179,843	8.0
Tulsa Int'l Airport	TUL	9	186,512	199,383	6.9
Salt Lake City Int'l Airport	SLC	10	349,699	373,815	6.9
Austin Municipal Airport	AUS	11	201,409	215,055	6.8
Los Angeles Int'l Airport	LAX	12	716,293	764,002	6.7
San Diego Int'l Lindberg Field	SAN	13	228,740	243,595	6.5
Detroit Metropolitan Airport	DTW	14	498,887	531,098	6.5
Raleigh-Durham Int'l Airport	RDU	15	214,011	227,816	6.5
Fort Myers Regional Airport	RSW	16	67,026	71,231	6.3
Washington Dulles Int'l Airport	IAD	17	311,279	330,439	6.2
Sarasota Bradenton Airport	SRQ	18	145,886	154,833	6.1
Dallas-Love Field	DAL	19	208,768	220,651	5.7
Charleston AFB Int'l Airport	CHS	20	137,517	145,025	5.5
George Bush Intercontinental Airport	IAH	21	375,246	391,939	4.4
New York John F. Kennedy Int'l Airport	JFK	22	345,263	360,511	4.4
Tampa Int'l Airport	TPA	23	261,617	272,782	4.3
Phoenix Sky Harbor Int'l Airport	PHX	24	522,634	544,363	4.2
Seattle-Tacoma Int'l Airport	SEA	25	382,100	397,591	4.1
Port Columbus Int'l Airport	CMH	26	204,100	211,434	3.6
Minneapolis-St. Paul Int'l Airport	MSP	27	466,916	483,570	3.6
Newark Int'l Airport	EWR	28	428,703	443,431	3.4
Hartsfield Atlanta Int'l Airport	ATL	29	747,105	772,597	3.4
Tucson Int'l Airport	TUS	30	238,024	245,929	3.3
San Jose Int'l Airport	SJC	31	270,519	278,941	3.1
Dane County Regional	MSN	32	150,458	154,707	2.8
Houston William P. Hobby Airport	HOU	33	245,603	252,254	2.7
Metropolitan Oakland Int'l Airport	OAK	34	502,952	516,498	2.7
Kahului Airport	OGG	35	178,602	183,046	2.5
Norfolk Int'l Airport	ORF	36	135,793	139,079	2.4
Wichita Mid-Continent Airport	ICT	37	177,982	182,186	2.4
Memphis Int'l Airport	MEM	38	356,294	363,945	2.1
Guam Int'l	GUM	39	59,928	61,156	2.0
Chicago O'Hare Int'l Airport	ORD	40	892,330	909,186	1.9
San Juan Int'l Airport	SJU	41	183,082	186,273	1.7
Reno Cannon Int'l Airport	RNO	42	151,603	154,234	1.7

5. At the top 100 airports, ranked by growth in total operations.

Table A-5. Growth in Operations From 1995 to 1996[5]

City-Airport	Airport ID	Rank	Operations FY95	FY96	% Growth
Oklahoma City World Airport	OKC	43	149,275	151,828	1.7
Albuquerque Int'l Airport	ABQ	44	199,114	202,254	1.6
Kailua-Kona Keahole	KOA	45	72,057	73,110	1.5
Portland Int'l Airport	PDX	46	301,785	305,964	1.4
San Francisco Int'l Airport	SFO	47	436,907	442,281	1.2
Greer Greenville-Spartanburg Airport	GSP	48	58,978	59,371	0.7
Columbia Metropolitan Airport	CAE	49	106,544	107,107	0.5
Des Moines Int'l Airport	DSM	50	137,043	137,698	0.5
Savannah Int'l Airport	SAV	51	95,060	95,472	0.4
Burbank-Glendale-Pasadena Airport	BUR	52	184,366	184,843	0.3
Lambert St. Louis Int'l Airport	STL	53	516,021	517,352	0.3
Omaha Eppley Airfield	OMA	54	160,039	159,974	0.0
Honolulu Int'l Airport	HNL	55	376,224	374,965	-0.3
Dallas-Fort Worth Int'l Airport	DFW	56	873,510	869,831	-0.4
Orlando Int'l Airport	MCO	57	343,609	341,942	-0.5
Philadelphia Int'l Airport	PHL	58	409,148	406,121	-0.7
Fort Lauderdale Int'l Airport	FLL	59	238,108	236,342	-0.7
Palm Beach Int'l Airport	PBI	60	205,104	202,875	-1.1
Greater Pittsburgh Int'l Airport	PIT	61	452,900	447,436	-1.2
New York LaGuardia Airport	LGA	62	346,869	342,618	-1.2
Sacramento Int'l Airport	SMF	63	177,010	174,117	-1.6
Dayton Int'l Airport	DAY	64	151,248	148,343	-1.9
Washington National Airport	DCA	65	316,404	309,754	-2.1
Birmingham Airport	BHM	66	165,295	160,728	-2.8
Ontario Int'l Airport	ONT	67	158,302	153,924	-2.8
Louisville Int'l Airport	SDF	68	178,646	173,152	-3.1
Boston Logan Int'l Airport	BOS	69	478,253	462,507	-3.3
Greater Buffalo Int'l Airport	BUF	70	153,646	148,404	-3.4
Little Rock Adams Field	LIT	71	169,312	163,341	-3.5
Knoxville McGhee-Tyson Airport	TYS	72	136,507	131,598	-3.6
Charlotte/Douglas Int'l Airport	CLT	73	474,338	457,054	-3.6
Santa Ana John Wayne Airport	SNA	74	493,391	474,976	-3.7
Indianapolis Int'l Airport	IND	75	245,541	235,940	-3.9
Spokane Int'l Airport	GEG	76	119,701	114,767	-4.1
Jacksonville Int'l Airport	JAX	77	142,786	136,725	-4.2
Portland Int'l Jetport	PWM	78	120,234	115,032	-4.3
Richmond Int'l Airport	RIC	79	153,119	146,105	-4.6
Milwaukee Int'l Airport	MKE	80	209,939	199,584	-4.9
Syracuse Hancock Int'l Airport	SYR	81	153,066	145,512	-4.9
Miami Int'l Airport	MIA	82	576,609	546,487	-5.2
Chicago Midway Airport	MDW	83	268,575	254,351	-5.3
Kansas City Int'l Airport	MCI	84	207,518	196,405	-5.4

5. At the top 100 airports, ranked by growth in total operations.

Table A-5. Growth in Operations From 1995 to 1996[5]

City-Airport	Airport ID	Rank	Operations FY95	FY96	% Growth
Las Vegas McCarran Int'l Airport	LAS	85	508,077	479,625	-5.6
Harrisburg Int'l Airport	MDT	86	83,447	78,161	-6.3
Lubbock Int'l Airport	LBB	87	101,944	95,150	-6.7
Islip Long Island Mac Arthur Airport	ISP	88	188,314	175,750	-6.7
Greater Rochester Int'l Airport	ROC	89	190,053	177,267	-6.7
Denver Int'l Airport	DEN	90	487,225	454,234	-6.8
El Paso Int'l Airport	ELP	91	151,905	140,226	-7.7
New Orleans Int'l Airport	MSY	92	177,383	163,210	-8.0
Palm Springs Regional Airport	PSP	93	102,072	93,584	-8.3
Bradley Int'l Airport	BDL	94	176,382	160,752	-8.9
Baltimore-Washington Int'l Airport	BWI	95	296,932	270,156	-9.0
Grand Rapids Int'l Airport	GRR	96	151,742	138,020	-9.0
Providence Green State Airport	PVD	97	133,679	119,355	-10.7
Albany County Airport	ALB	98	150,986	132,928	-12.0
Greensboro Int'l Airport	GSO	99	173,259	143,661	-17.1
Nashville Int'l Airport	BNA	100	278,957	226,274	-18.9

Totals:

1995 Operations 26,114,095
1996 Operations 26,407,065
Average forecast growth at the top 100 airports 1.1

5. At the top 100 airports, ranked by growth in total operations.

Table A-6. Growth in Operations and Enplanements[6]

City-Airport	Airport ID	% Growth in Enplanements FY95-FY96	% Growth in Enplanements FY96-FY2011	% Growth in Operations FY95-FY96	% Growth in Operations FY96-FY2011
Albuquerque Int'l Airport	ABQ	5.1	80.8	1.6	29.5
Albany County Airport	ALB	-5.0	77.9	-12.0	32.4
Anchorage Int'l Airport	ANC	-9.9	83.4	30.2	38.2
Hartsfield Atlanta Int'l Airport	ATL	12.1	47.7	3.4	25.8
Austin Municipal Airport	AUS	5.9	85.3	6.8	28.3
Bradley Int'l Airport	BDL	5.9	80.1	-8.9	26.9
Birmingham Airport	BHM	9.9	85.7	-2.8	15.7
Nashville Int'l Airport	BNA	-12.3	108.1	-18.9	36.1
Boise Air Terminal	BOI	17.8	88.4	8.0	29.6
Boston Logan Int'l Airport	BOS	2.5	40.2	-3.3	13.1
Greater Buffalo Int'l Airport	BUF	-4.7	45.6	-3.4	21.3
Burbank-Glendale-Pasadena Airport	BUR	-0.3	102.7	0.3	31.5
Baltimore-Washington Int'l Airport	BWI	-0.6	78.5	-9.0	39.5
Columbia Metropolitan Airport	CAE	-4.7	31.7	0.5	4.6
Charleston AFB Int'l Airport	CHS	-5.9	84.4	5.5	6.9
Cleveland Hopkins Int'l Airport	CLE	1.8	79.7	8.6	39.8
Charlotte/Douglas Int'l Airport	CLT	2.4	62.2	-3.6	31.9
Port Columbus Int'l Airport	CMH	11.7	94.5	3.6	31.0
Colorado Springs Municipal Airport	COS	105.8	84.1	10.2	30.3
Greater Cincinnati Int'l Airport	CVG	23.8	127.0	9.9	76.6
Dallas-Love Field	DAL	2.5	68.6	5.7	27.8
Dayton Int'l Airport	DAY	-15.5	7.5	-1.9	17.3
Washington National Airport	DCA	-2.1	27.4	-2.1	5.6
Denver Int'l Airport	DEN	1.7	47.8	-6.8	29.9
Dallas-Fort Worth Int'l Airport	DFW	1.5	81.8	-0.4	57.3
Des Moines Int'l Airport	DSM	23.9	82.5	0.5	13.3
Detroit Metropolitan Airport	DTW	7.0	89.2	6.5	45.9
El Paso Int'l Airport	ELP	-2.8	91.3	-7.7	17.0
Newark Int'l Airport	EWR	5.6	62.5	3.4	35.5
Fort Lauderdale Int'l Airport	FLL	10.9	109.3	-0.7	39.6
Spokane Int'l Airport	GEG	9.2	107.6	-4.1	42.0
Grand Rapids Int'l Airport	GRR	4.5	83.0	-9.0	26.8
Greensboro Int'l Airport	GSO	-21.6	97.9	-17.1	27.4
Greer Greenville-Spartanburg Airport	GSP	-1.8	86.3	0.7	24.6
Guam Int'l	GUM	30.6	101.9	2.0	19.4
Honolulu Int'l Airport	HNL	1.7	62.2	-0.3	33.6
Houston William P. Hobby Airport	HOU	1.0	46.7	2.7	18.9
Washington Dulles Int'l Airport	IAD	5.7	83.6	6.2	30.1
George Bush Intercontinental Airport	IAH	3.6	92.4	4.4	61.0
Wichita Mid-Continent Airport	ICT	19.8	32.4	2.4	13.6
Indianapolis Int'l Airport	IND	9.7	90.4	-3.9	43.7
Islip Long Island Mac Arthur Airport	ISP	-1.0	90.1	-6.7	0.7

6. At the top 100 airports, listed in alphabetical order by Airport Identifier.

Table A-6. Growth in Operations and Enplanements[6]

City-Airport	Airport ID	% Growth in Enplanements FY95-FY96	% Growth in Enplanements FY96-FY2011	% Growth in Operations FY95-FY96	% Growth in Operations FY96-FY2011
Hilo Int'l Airport	ITO	6.0	71.6	10.5	23.3
Jacksonville Int'l Airport	JAX	0.4	94.4	-4.2	32.4
New York John F. Kennedy Int'l Airport	JFK	4.7	52.2	4.4	18.2
Kailua-Kona Keahole	KOA	5.0	106.3	1.5	35.4
Las Vegas McCarran Int'l Airport	LAS	9.8	113.4	-5.6	54.7
Los Angeles Int'l Airport	LAX	8.0	66.7	6.7	33.4
Lubbock Int'l Airport	LBB	1.9	36.0	-6.7	-3.3
New York LaGuardia Airport	LGA	-0.6	46.1	-1.2	15.0
Lihue Airport	LIH	6.3	70.5	11.0	45.1
Little Rock Adams Field	LIT	-0.4	101.7	-3.5	16.9
Kansas City Int'l Airport	MCI	6.0	57.8	-5.4	33.4
Orlando Int'l Airport	MCO	11.4	125.7	-0.5	67.3
Harrisburg Int'l Airport	MDT	-9.5	44.4	-6.3	3.6
Chicago Midway Airport	MDW	4.6	71.4	-5.3	28.2
Memphis Int'l Airport	MEM	8.6	72.9	2.1	51.7
Miami Int'l Airport	MIA	2.3	97.0	-5.2	39.4
Milwaukee Int'l Airport	MKE	5.4	87.1	-4.9	33.3
Dane County Regional	MSN	5.9	40.3	2.8	9.2
Minneapolis-St. Paul Int'l Airport	MSP	8.8	76.2	3.6	39.0
New Orleans Int'l Airport	MSY	1.3	56.9	-8.0	23.2
Metropolitan Oakland Int'l Airport	OAK	1.9	85.1	2.7	18.5
Kahului Airport	OGG	1.4	80.5	2.5	27.8
Oklahoma City World Airport	OKC	3.1	110.3	1.7	10.0
Omaha Eppley Airfield	OMA	17.0	74.8	0.0	35.0
Ontario Int'l Airport	ONT	-1.4	62.5	-2.8	25.4
Chicago O'Hare Int'l Airport	ORD	1.8	52.8	1.9	21.5
Norfolk Int'l Airport	ORF	-3.6	88.4	2.4	20.1
Palm Beach Int'l Airport	PBI	4.3	52.9	-1.1	8.9
Portland Int'l Airport	PDX	11.1	93.5	1.4	41.8
Philadelphia Int'l Airport	PHL	2.5	84.7	-0.7	34.0
Phoenix Sky Harbor Int'l Airport	PHX	7.8	9.7	4.2	6.7
Greater Pittsburgh Int'l Airport	PIT	1.2	175.1	-1.2	72.8
Palm Springs Regional Airport	PSP	20.1	98.5	-8.3	13.3
Providence Green State Airport	PVD	-3.9	107.5	-10.7	30.7
Portland Int'l Jetport	PWM	0.4	32.7	-4.3	13.0
Raleigh-Durham Int'l Airport	RDU	-3.7	82.1	6.5	22.5
Richmond Int'l Airport	RIC	-1.6	73.8	-4.6	21.1
Reno Cannon Int'l Airport	RNO	13.1	106.8	1.7	36.2
Greater Rochester Int'l Airport	ROC	-2.8	87.2	-6.7	23.5
Fort Myers Regional Airport	RSW	5.0	126.2	6.3	82.5
San Diego Int'l Lindberg Field	SAN	3.3	71.4	6.5	40.4
San Antonio Int'l Airport	SAT	7.1	93.4	8.4	29.7

6. At the top 100 airports, listed in alphabetical order by Airport Identifier.

Table A-6. Growth in Operations and Enplanements[6]

City-Airport	Airport ID	% Growth in Enplanements FY95-FY96	% Growth in Enplanements FY96-FY2011	% Growth in Operations FY95-FY96	% Growth in Operations FY96-FY2011
Savannah Int'l Airport	SAV	5.5	76.9	0.4	8.9
Louisville Int'l Airport	SDF	-1.3	85.3	-3.1	33.4
Seattle-Tacoma Int'l Airport	SEA	4.9	66.5	4.1	36.6
San Francisco Int'l Airport	SFO	8.5	71.8	1.2	42.0
San Jose Int'l Airport	SJC	10.2	91.8	3.1	23.3
San Juan Int'l Airport	SJU	-0.5	60.9	1.7	24.5
Salt Lake City Int'l Airport	SLC	13.3	79.6	6.9	44.5
Sacramento Int'l Airport	SMF	4.6	89.4	-1.6	41.9
Santa Ana John Wayne Airport	SNA	1.6	107.7	-3.7	29.5
Sarasota Bradenton Airport	SRQ	1.1	98.8	6.1	18.8
Lambert St. Louis Int'l Airport	STL	6.2	70.8	0.3	33.0
Syracuse Hancock Int'l Airport	SYR	-3.2	36.2	-4.9	29.2
Tampa Int'l Airport	TPA	9.8	65.5	4.3	32.0
Tulsa Int'l Airport	TUL	4.5	115.4	6.9	22.9
Tucson Int'l Airport	TUS	2.3	106.7	3.3	10.2
Knoxville McGhee-Tyson Airport	TYS	4.0	90.3	-3.6	21.6

Totals:

Average growth at the top 100 airports .... 5.0 .... 0.1

Average forecast growth at the top 100 airports for the 15 year period .... 78.6 .... 29.1

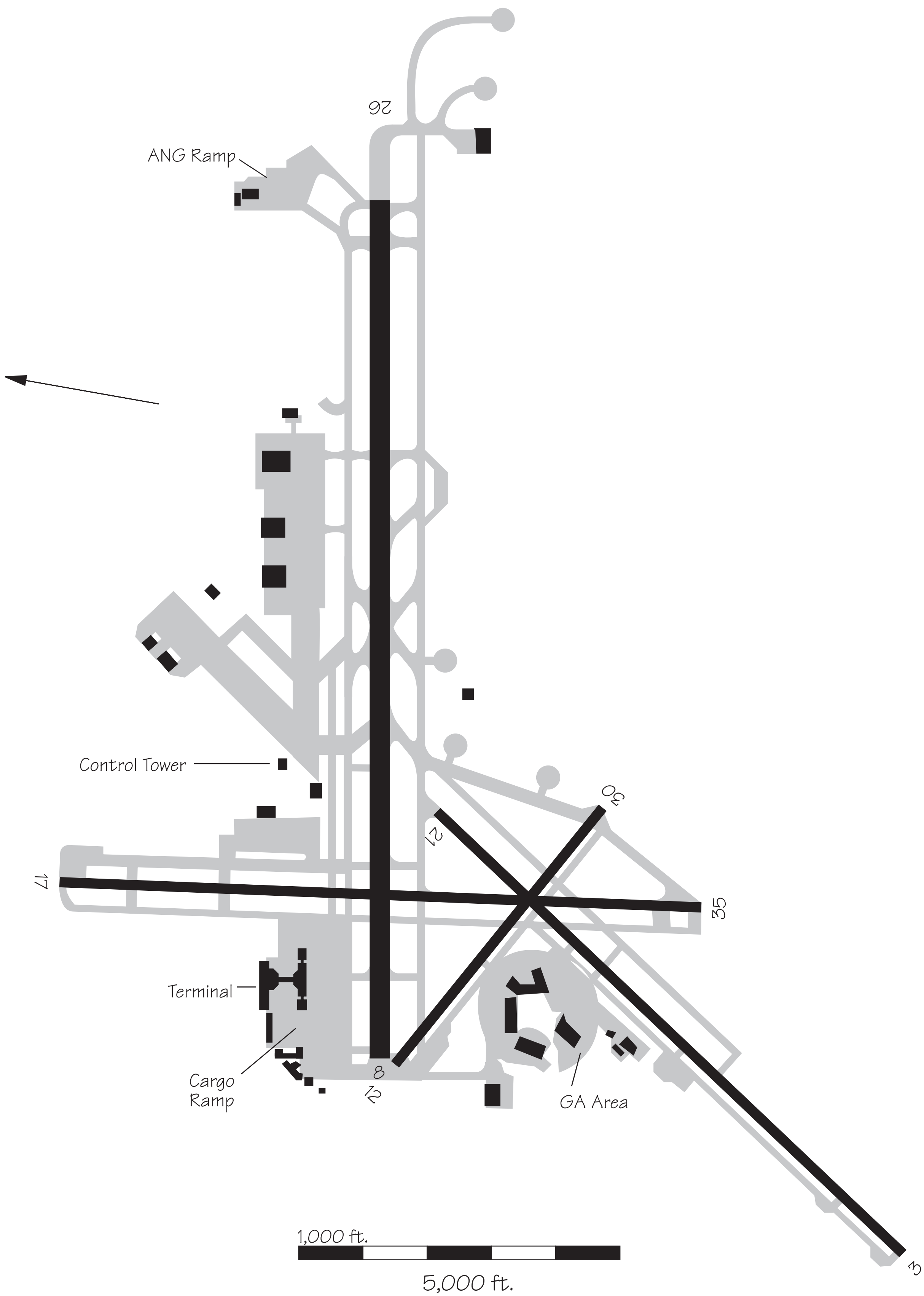
6. At the top 100 airports, listed in alphabetical order by Airport Identifier.

APPENDIX B: TOP 100 AIRPORTS

This appendix contains current airport diagrams for the top 100 airports.[1] For those airports that are considering or have plans for the construction of new runways or extensions to existing runways, the diagrams show the proposed runway and runway extension projects indicated in blue. These diagrams are for illustration only, and should not be used in any way for airport planning purposes. Accompanying the diagrams is a brief narrative of construction projects being planned or considered.

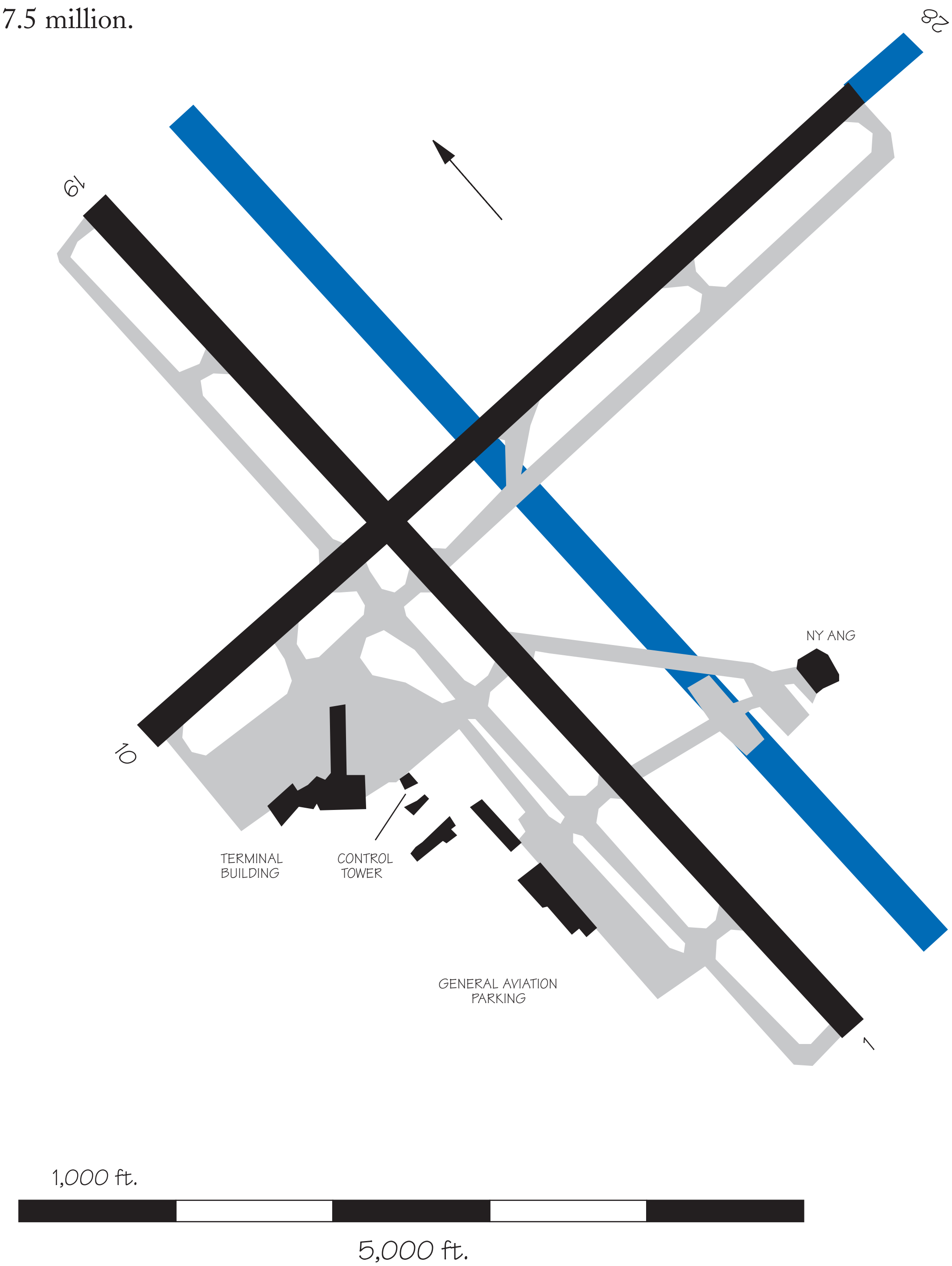
1. Based on 1996 passenger enplanements (see Appendix A, Table A-1).

ABQ — Albuquerque International Airport

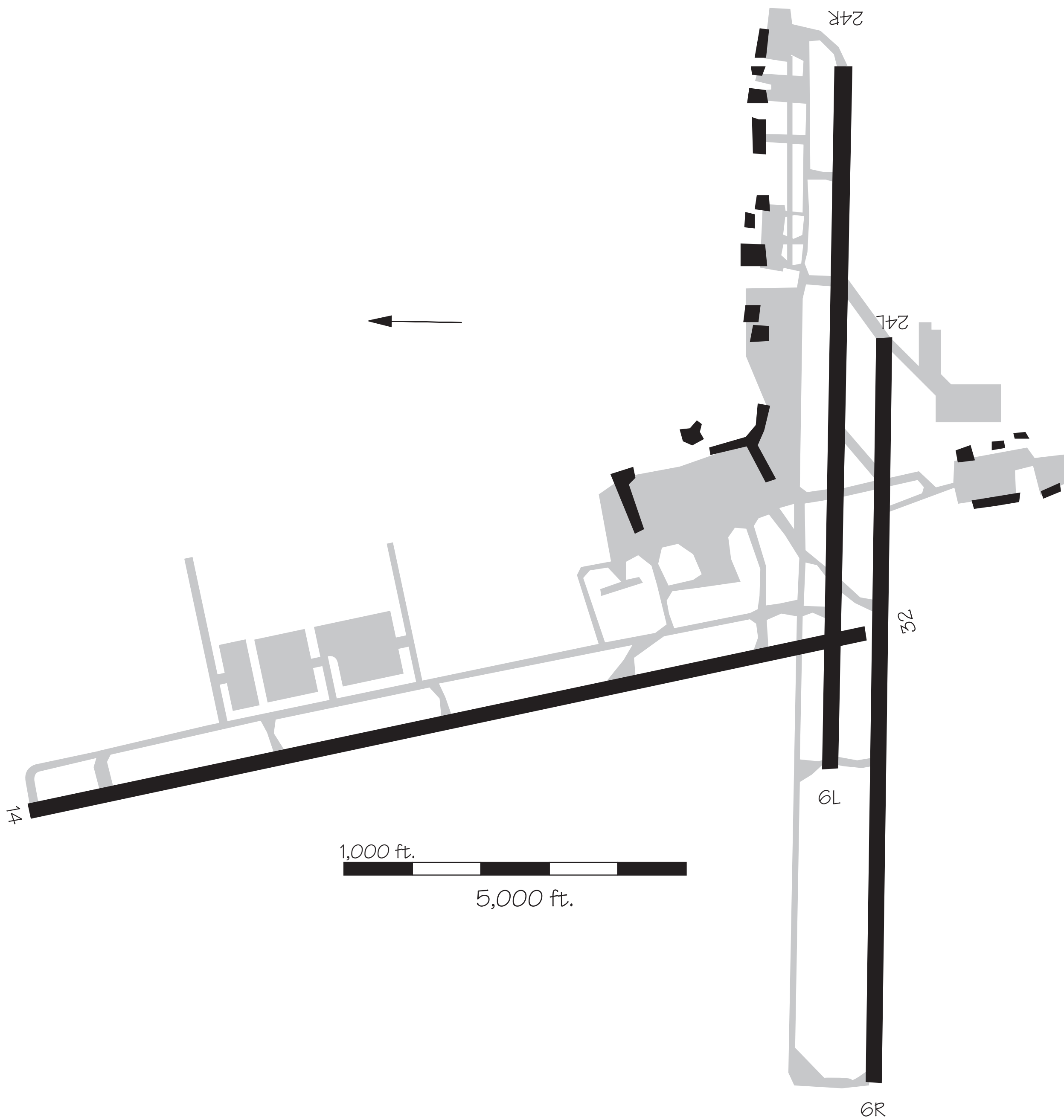


ALB — Albany County Airport

Construction of an extension to Runway 10/28 is planned. The estimated cost of construction is $5.8 million. A new parallel Runway 1R/19L is also planned. The estimated cost is $7.5 million.

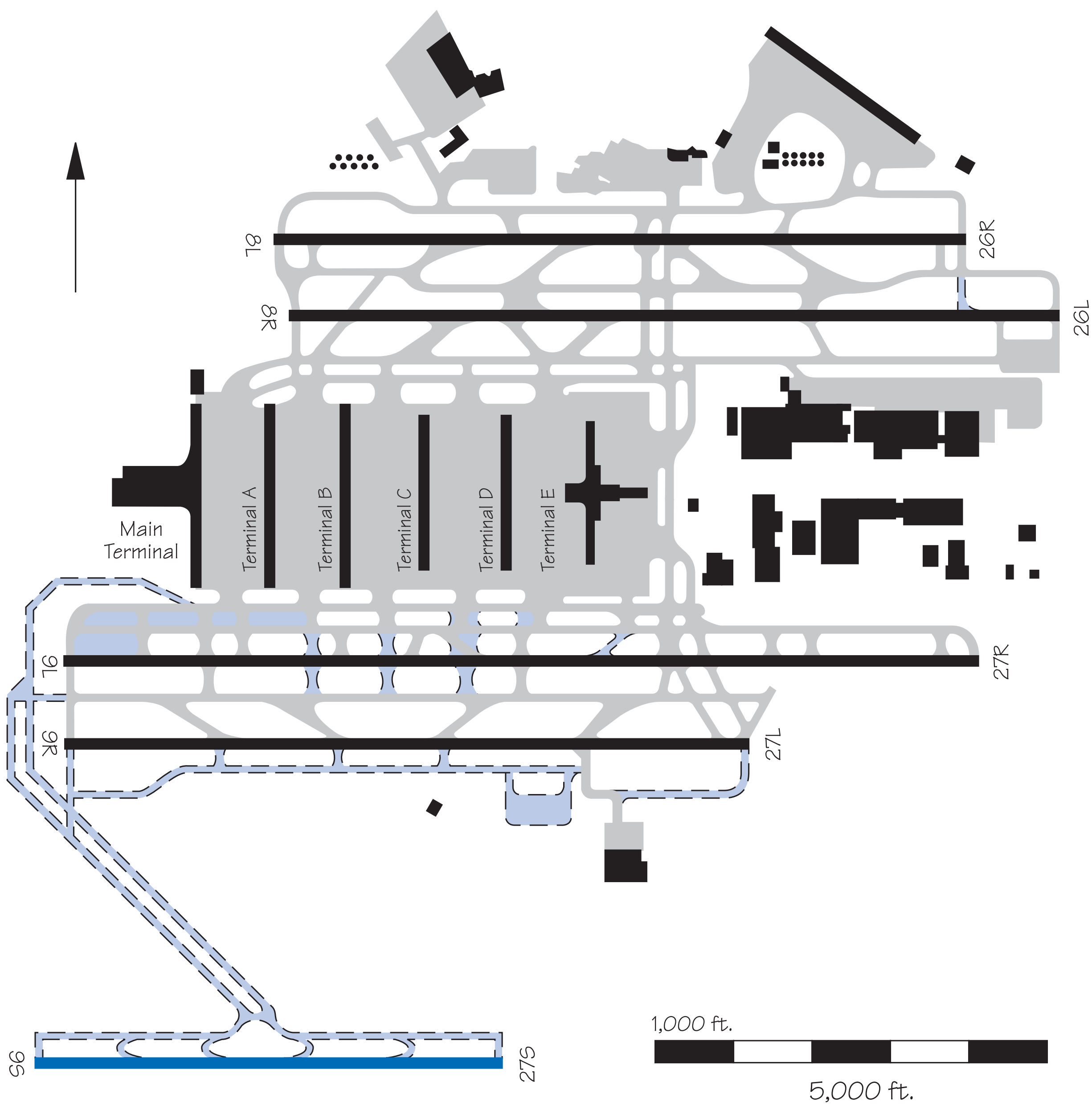


ANC — Anchorage International Airport

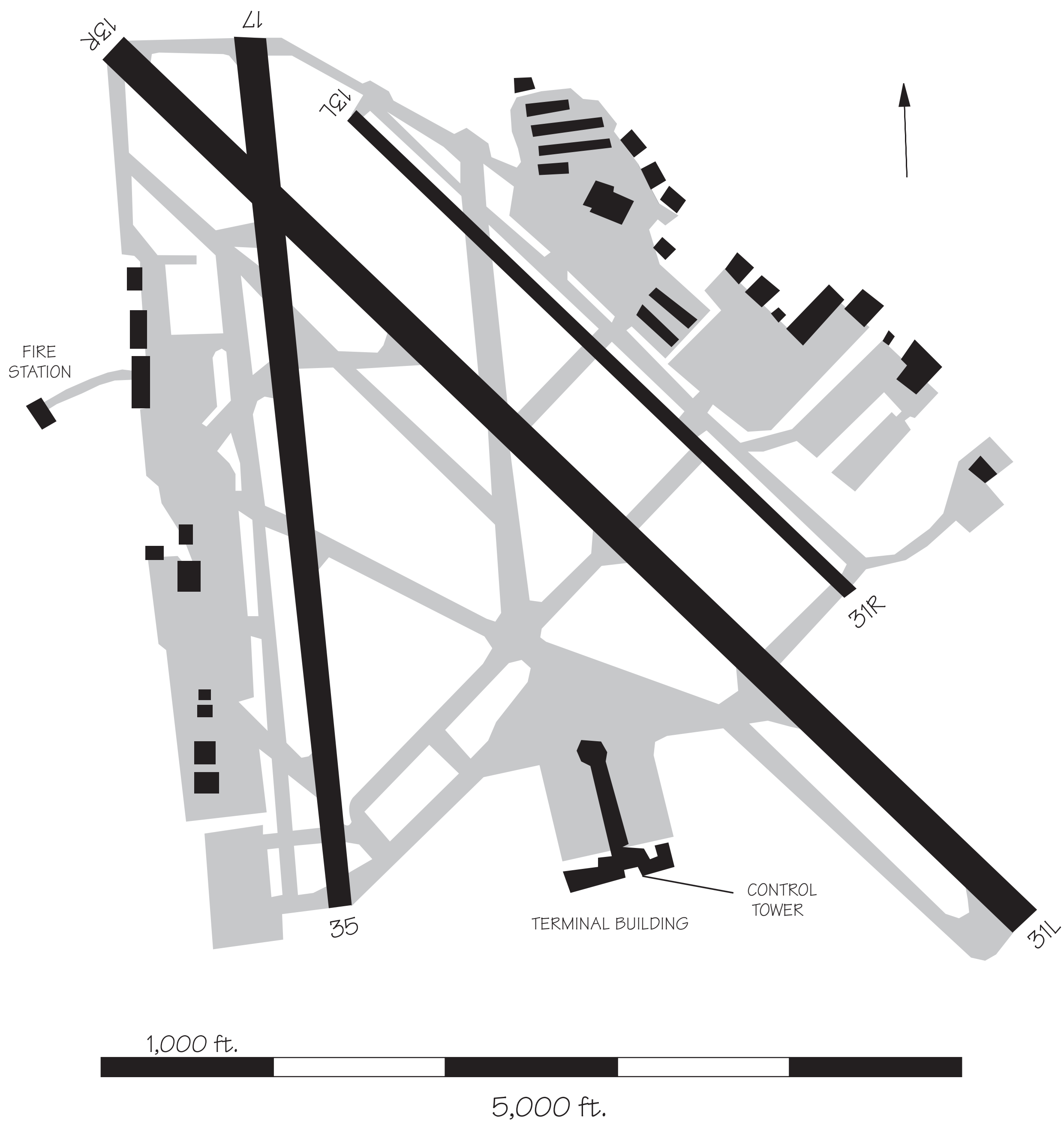


ATL — Hartsfield Atlanta International Airport

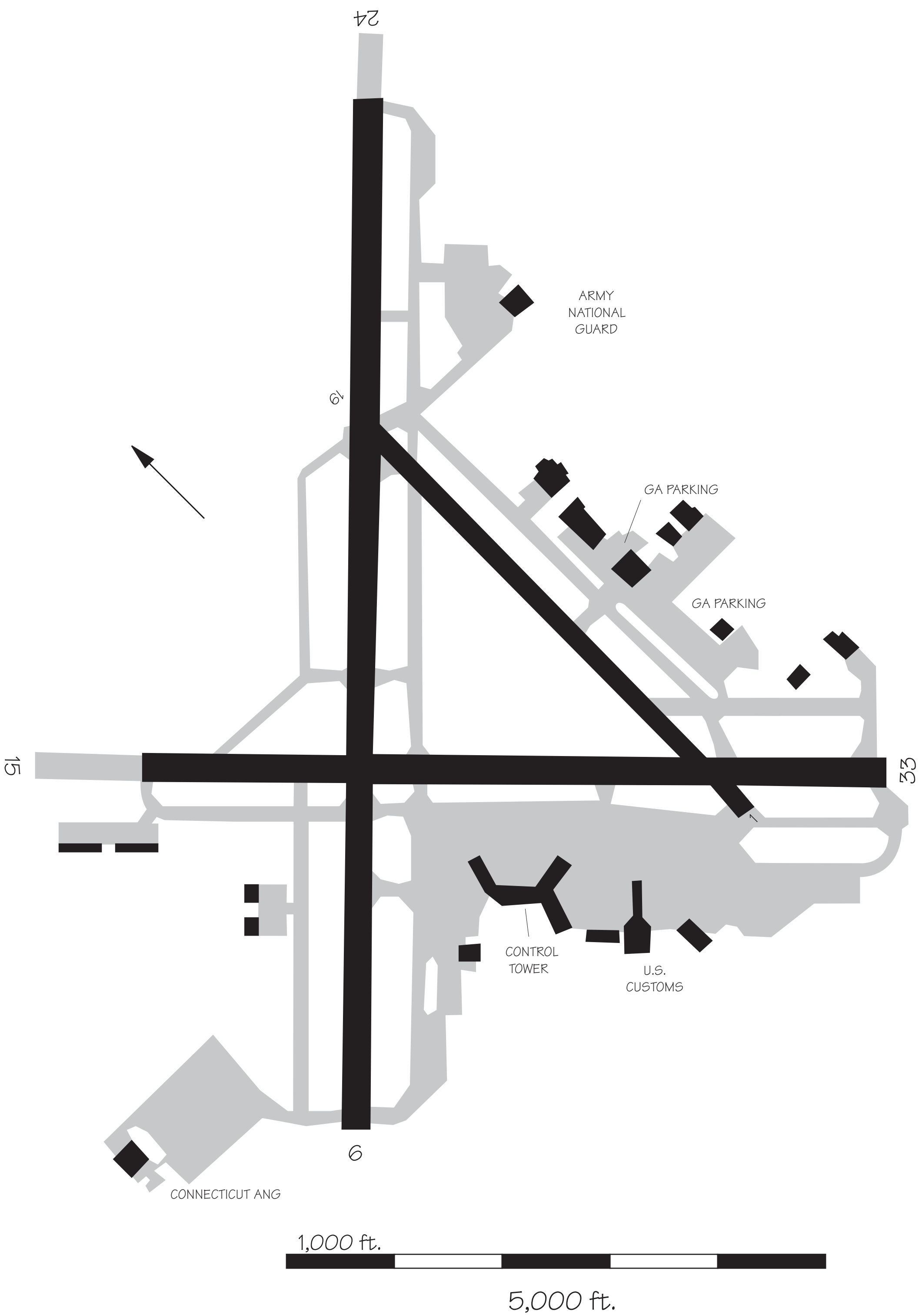
A fifth parallel commuter runway, 6,000 feet long and approximately 4,200 feet south of Runway 9R/27L, is under design. Land acquisition is ongoing. The runway will permit triple independent IFR approaches using the PRM. The total estimated cost is $440 million. Construction is expected to begin in early 1998. The estimated operational date is early 2002.



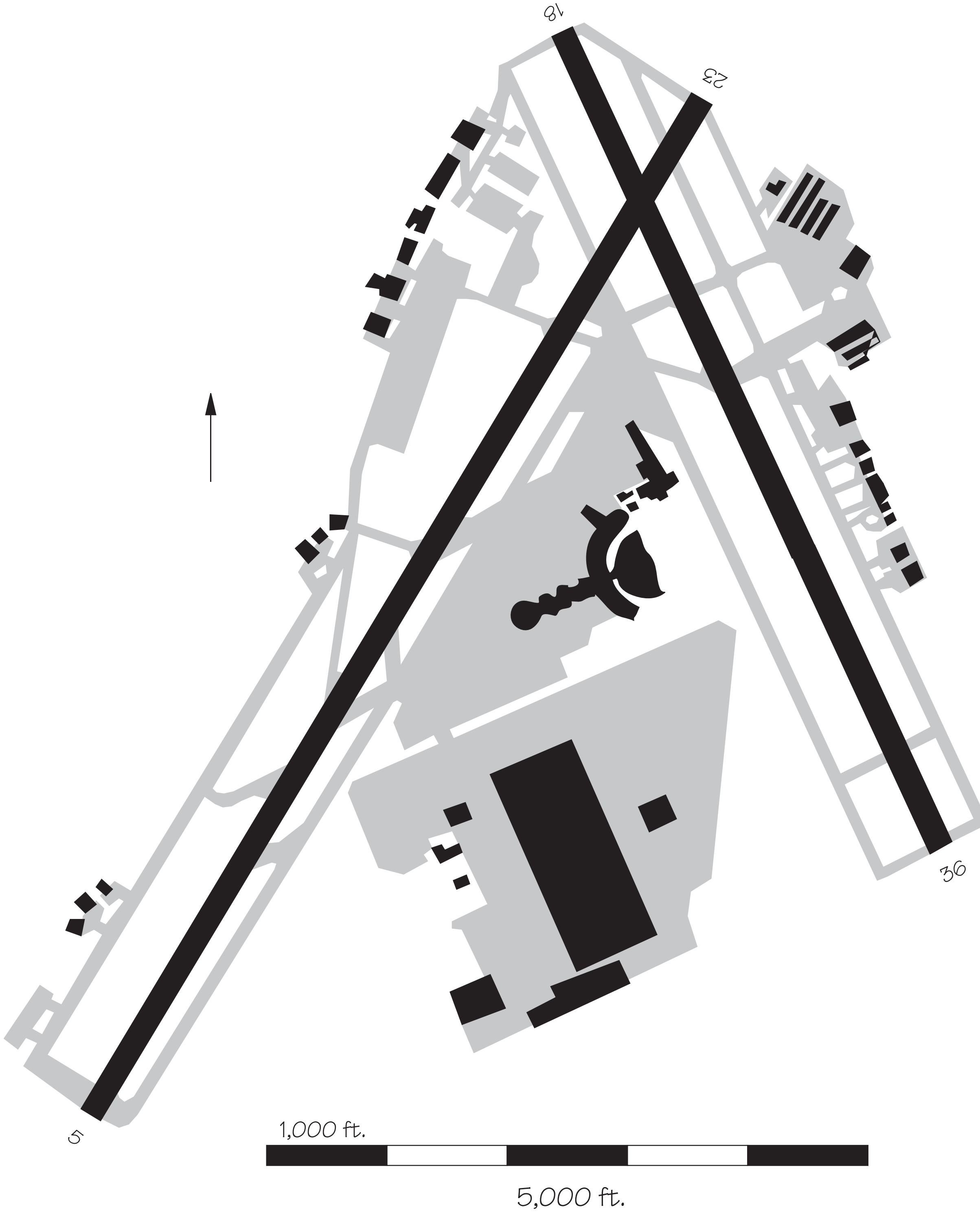
AUS — Austin Robert Mueller Airport



BDL — Bradley International Airport

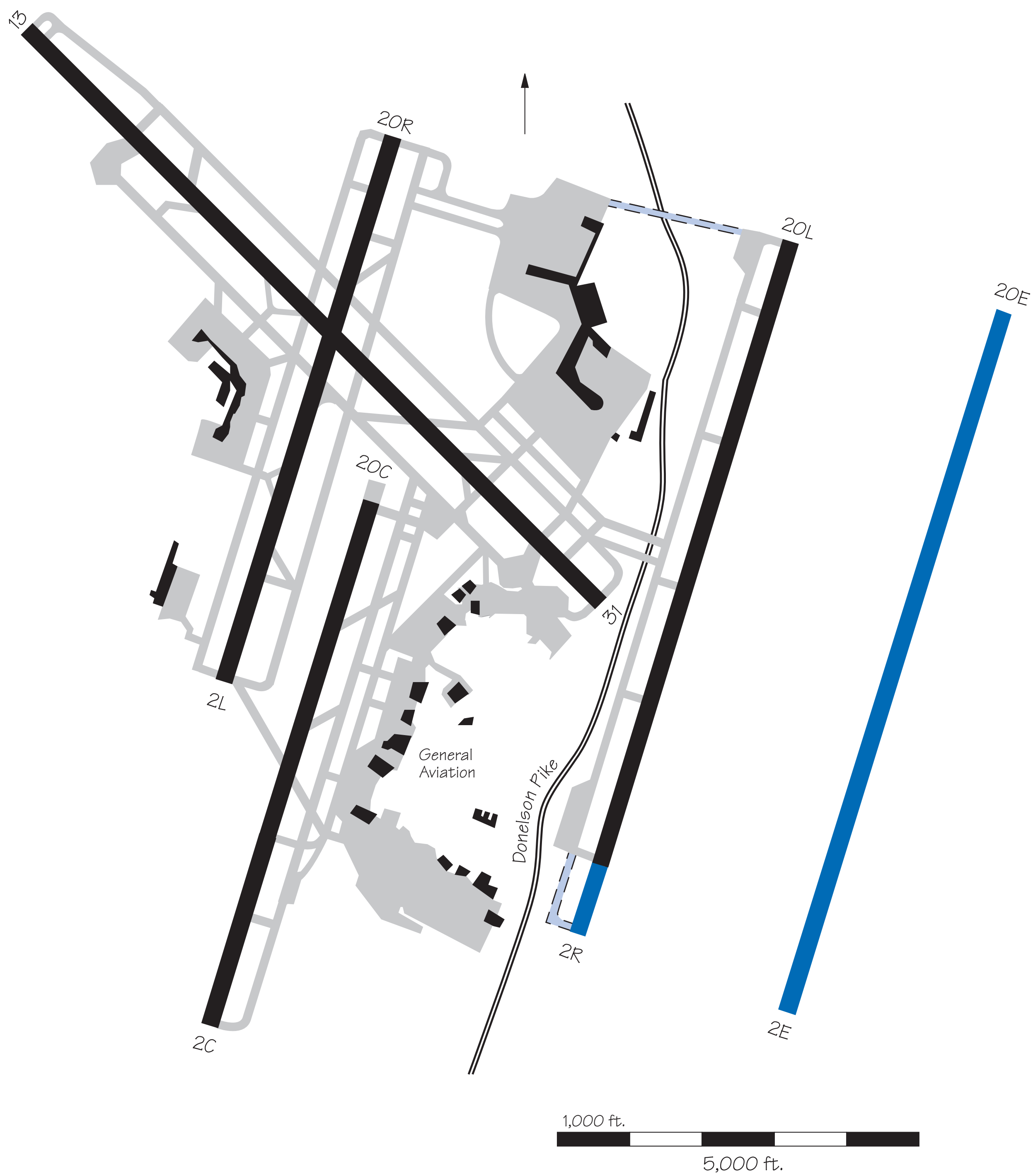


BHM — Birmingham Airport

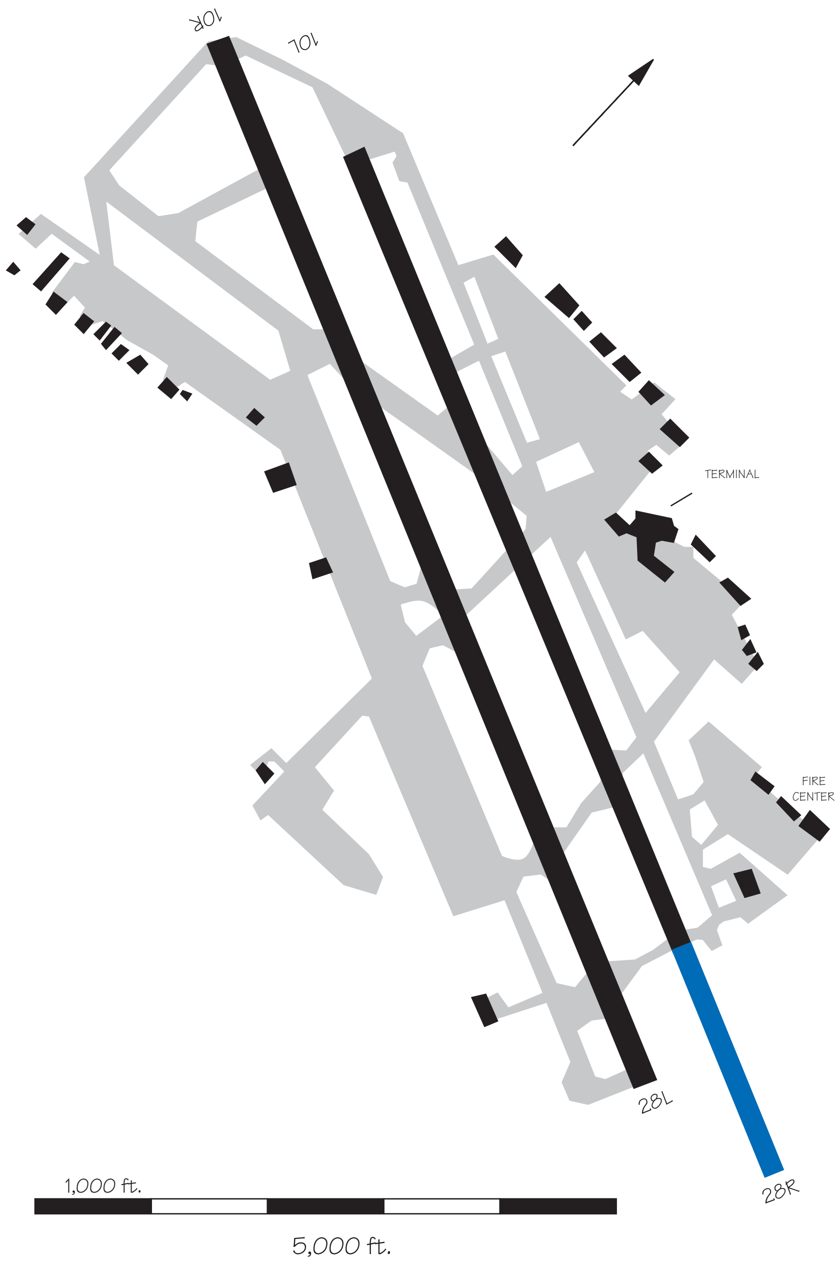


BNA — Nashville International Airport

A new Runway 2E/20E is planned for the future between 1,500 and 3,500 feet from Runway 2R/20L. In addition, an extension to Runway 2R/20L is planned.

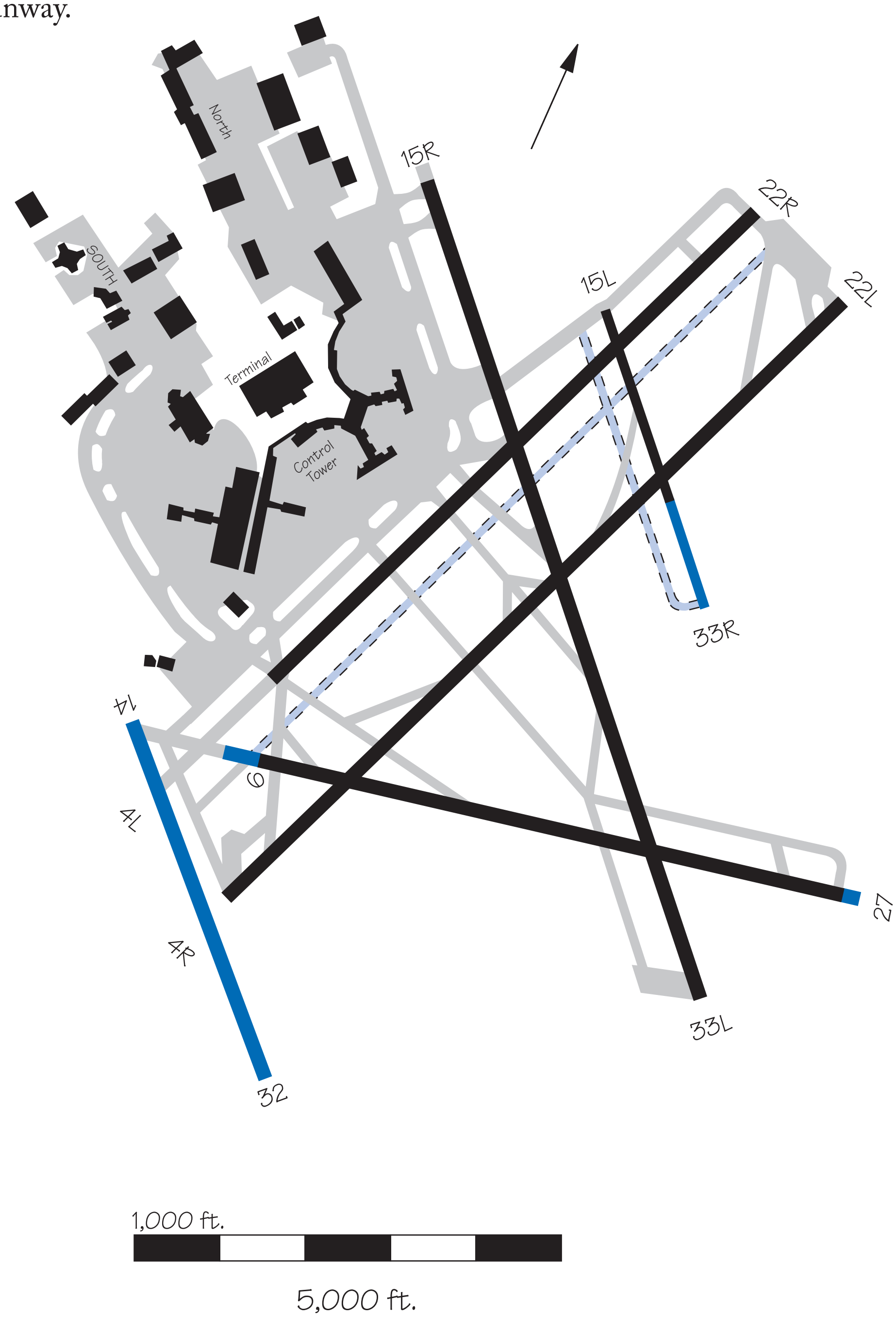


BOI — Boise Air Terminal



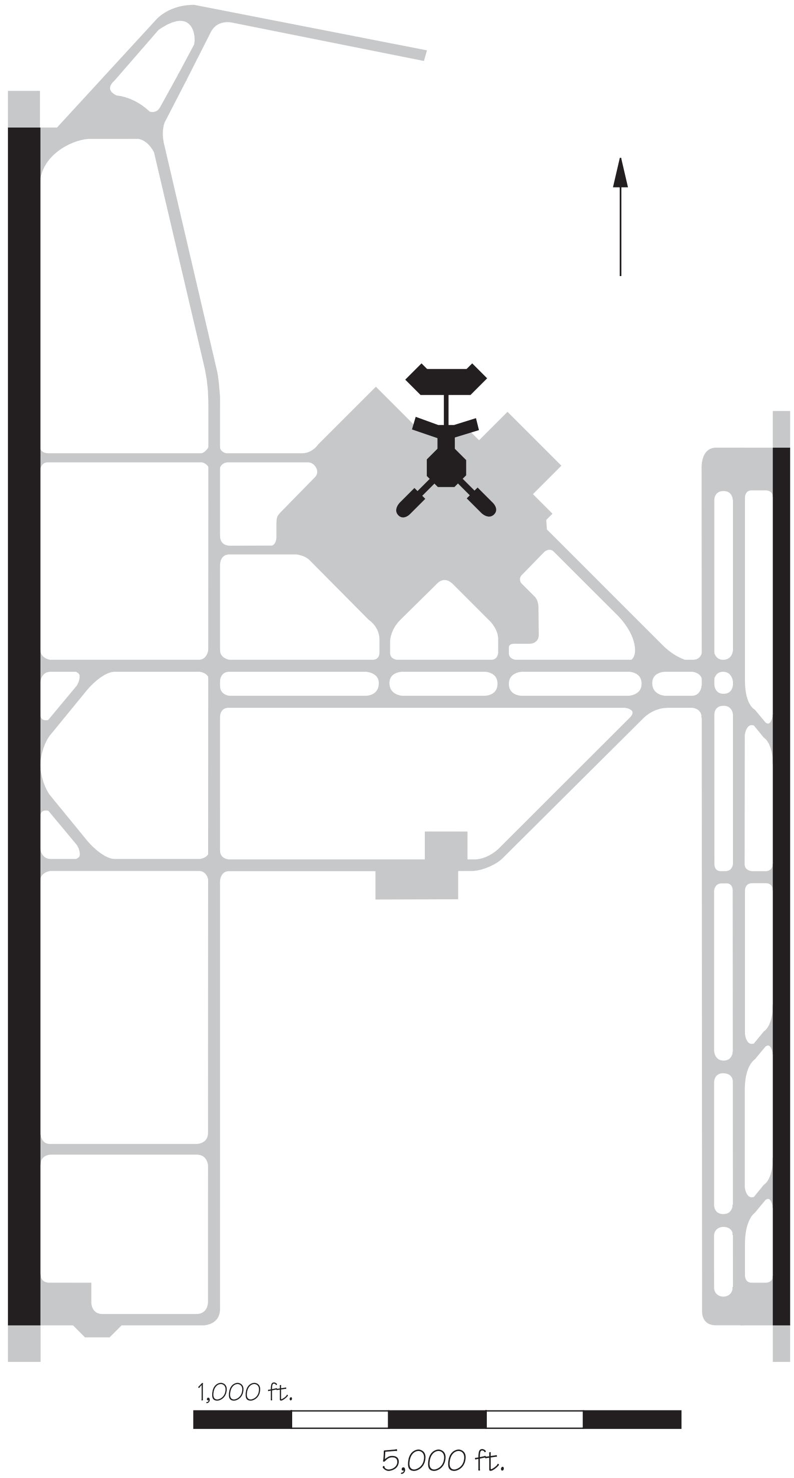
BOS — Boston Logan International Airport

A new uni-directional commuter runway (Runway 14/32) 4,300 feet from Runway 15R/33L, an extension of Runway 15L/33R to 3,500 feet, and a 400-foot extension of Runway 9 are being studied. An Environmental Impact Study is currently in progress for the new runway.



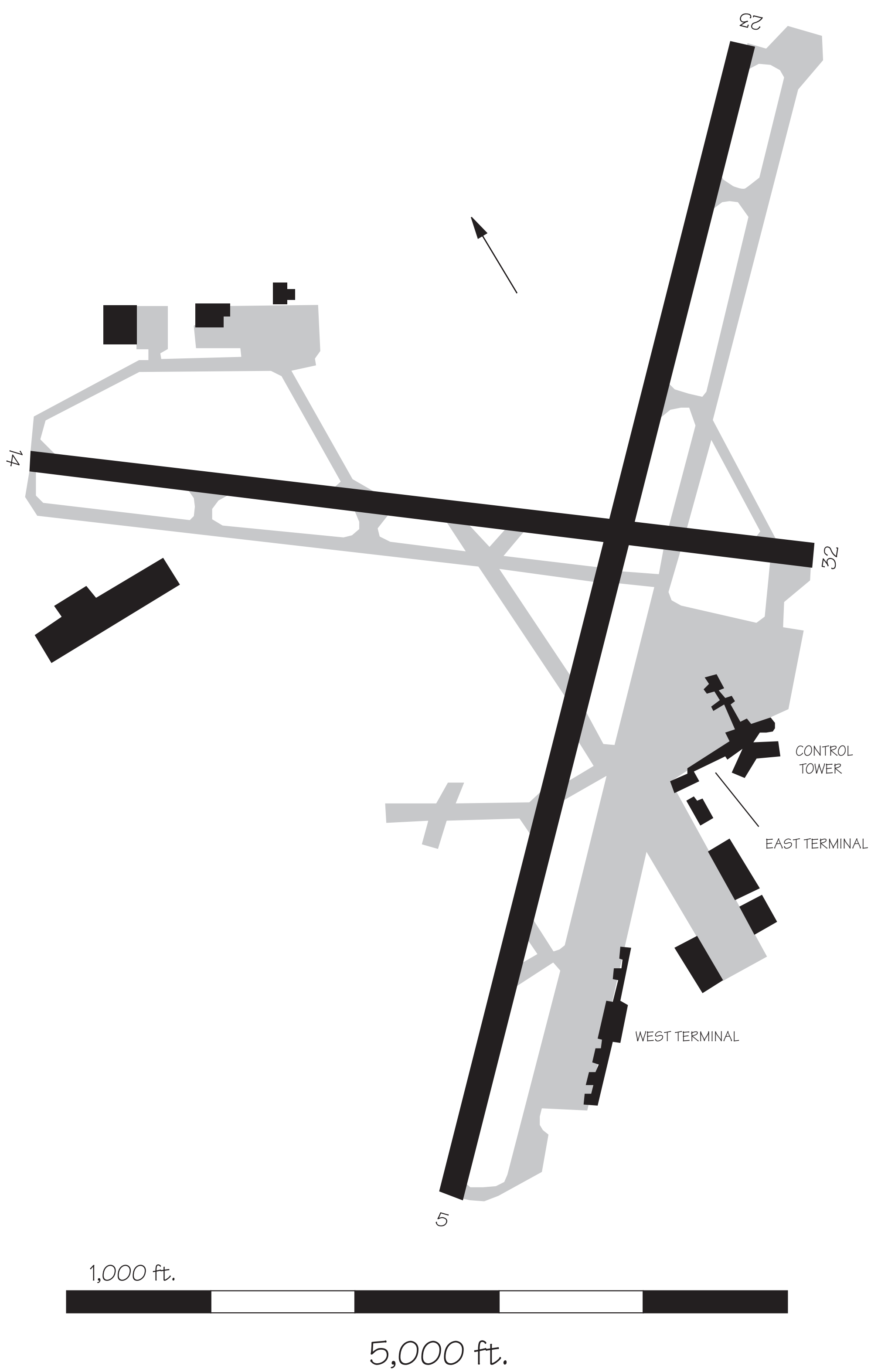
BSM — Bergstrom AFB (new Austin)

The community has approved the sale of revenue bonds for the development of a new airport. The present Robert Mueller Airport cannot be expanded. Bergstrom Air Force Base (AFB) was transferred to the city on October 1, 1993, and the city is now planning to construct a new parallel runway and relocate all commercial activity there in 1998. The total estimated project cost is $520 million. The city has an Airport Master Plan under development. Environmental studies are in progress by the Air Force and the city. Since Robert Mueller Airport will close upon completion of the new airport, no capacity enhancements are planned at Mueller. Some of the construction projects include a new Runway 17L/35R and associated taxiways, new midfield cross taxiways, a new air cargo apron, and renovation of Runway 17R/35L to bring it up to FAA CAT III standards.



Bergstrom Air Force Base Conversion
Opening Day Layout Plan
as of 1-31-95

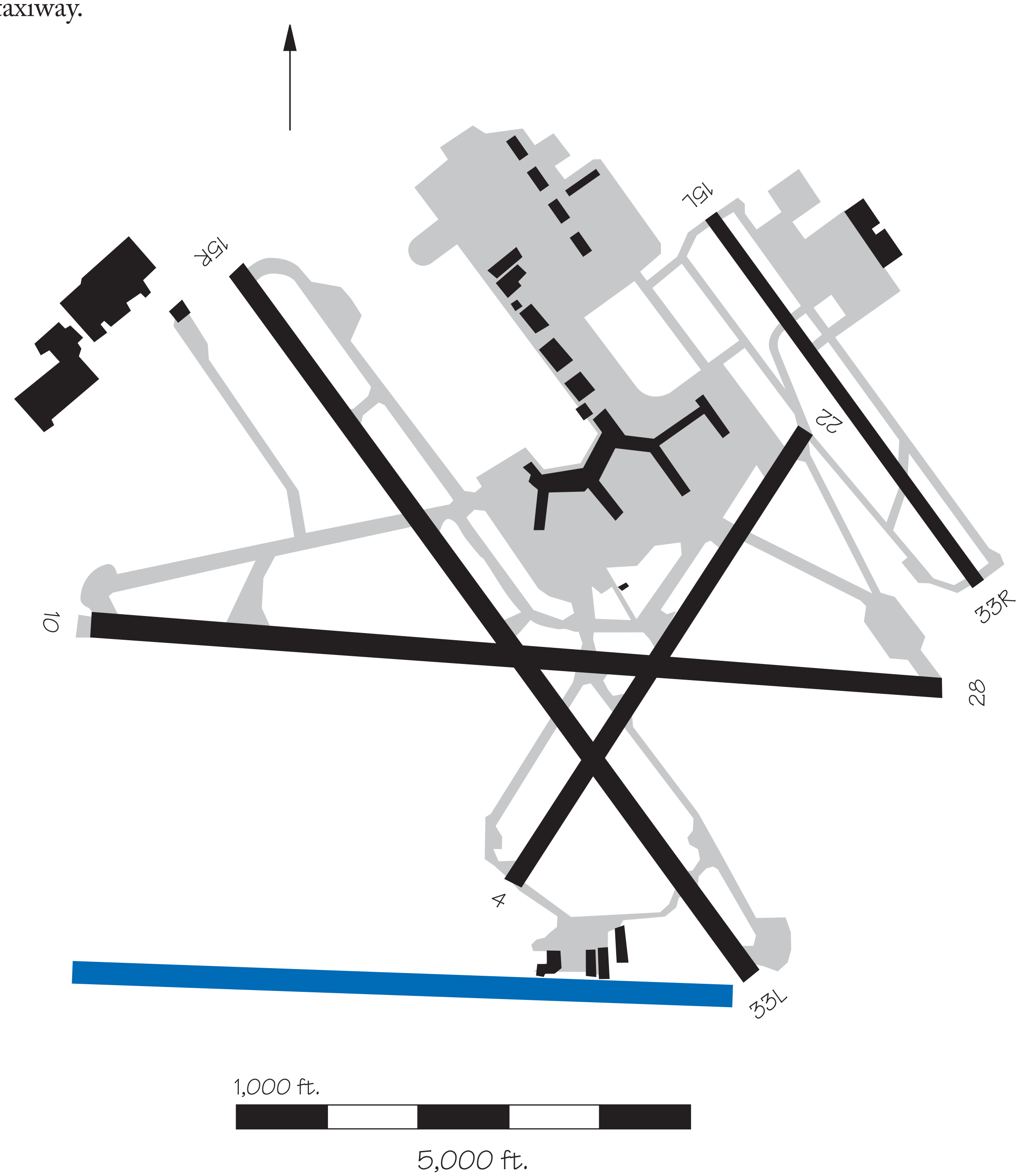
BUF — Greater Buffalo International Airport



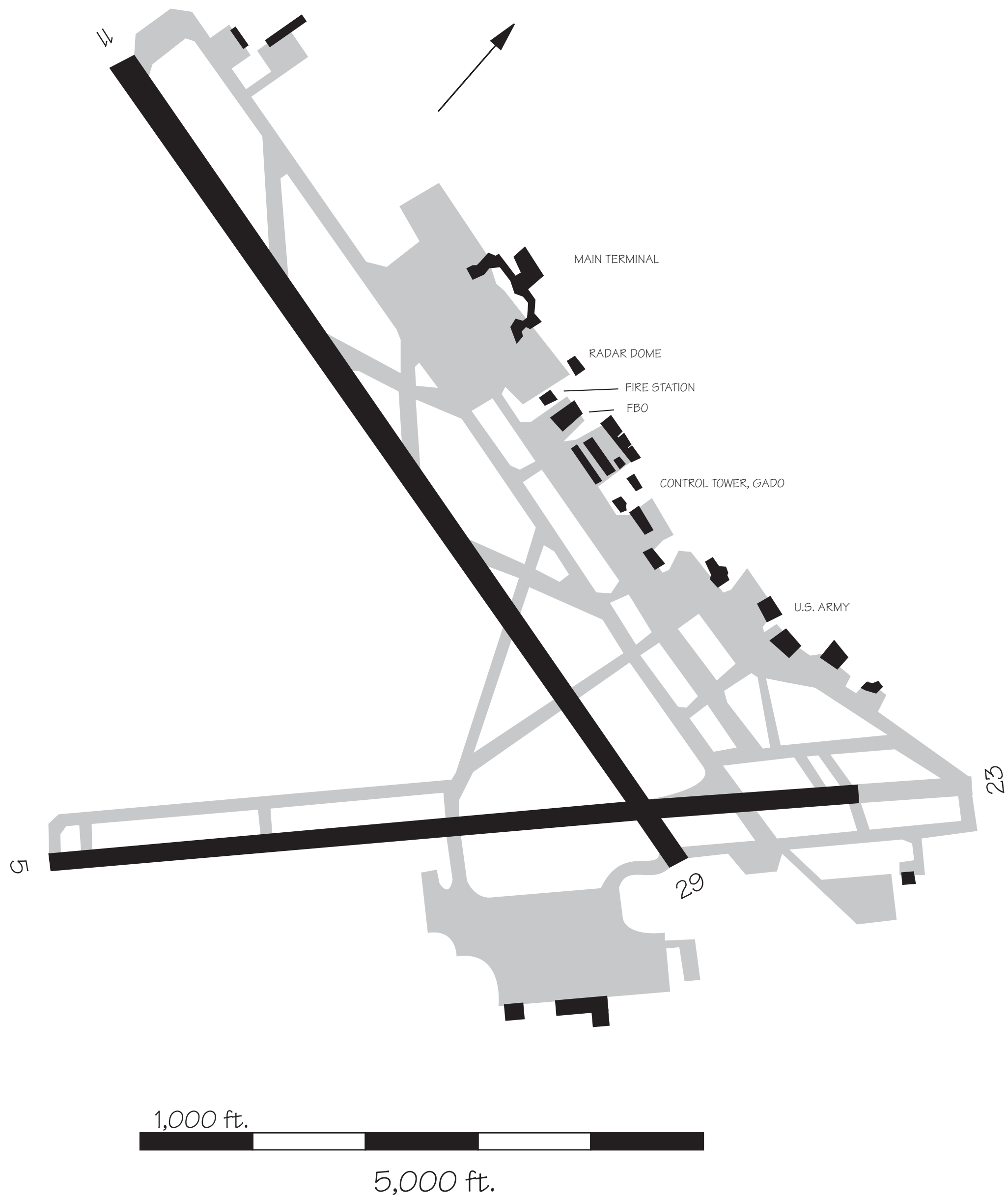
BUR — Burbank-Glendale-Pasadena Airport

BWI — Baltimore-Washington International Airport

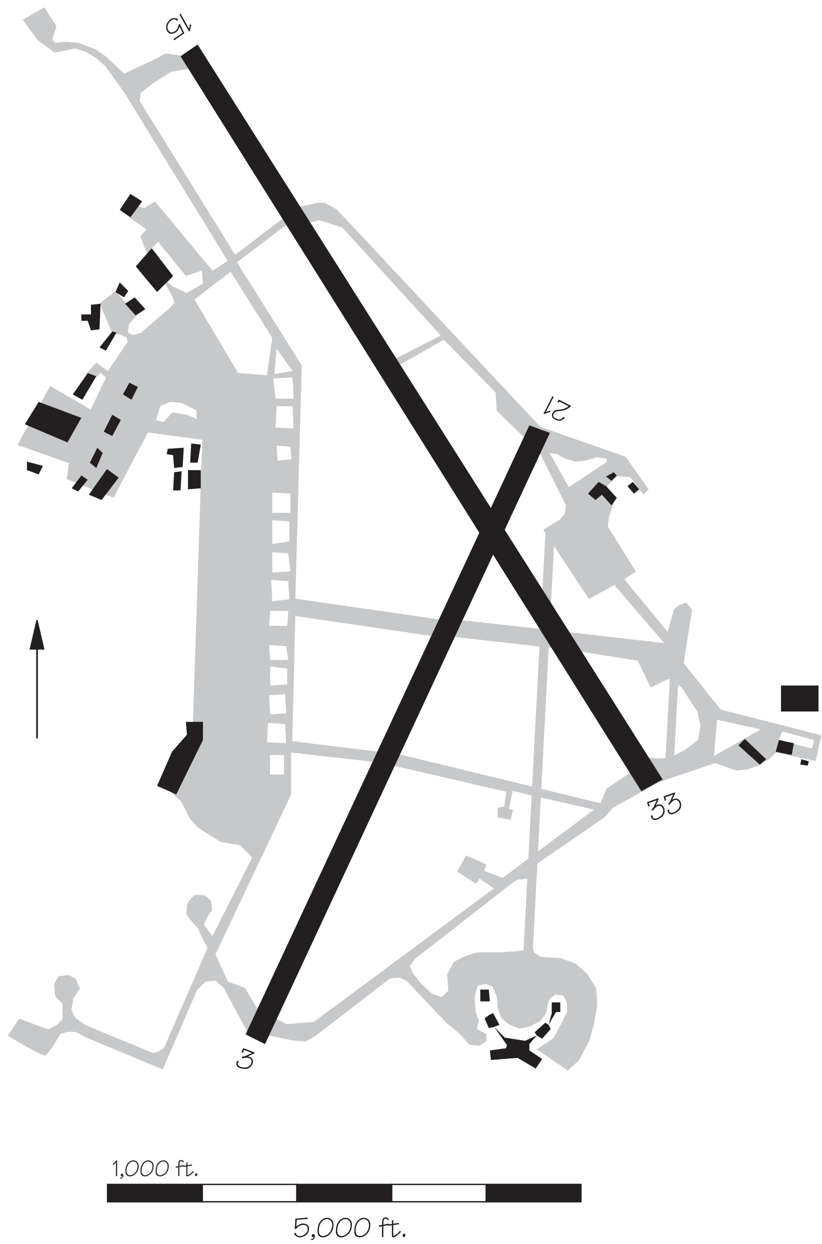
A new 7,800-foot runway, Runway 10R/28L, is planned to be constructed by 2003, 3,500 feet south of Runway 10/28. When Runway 10R/28L is constructed, Runway 4/22 will be converted to a taxiway.



CAE — Columbia Metropolitan Airport

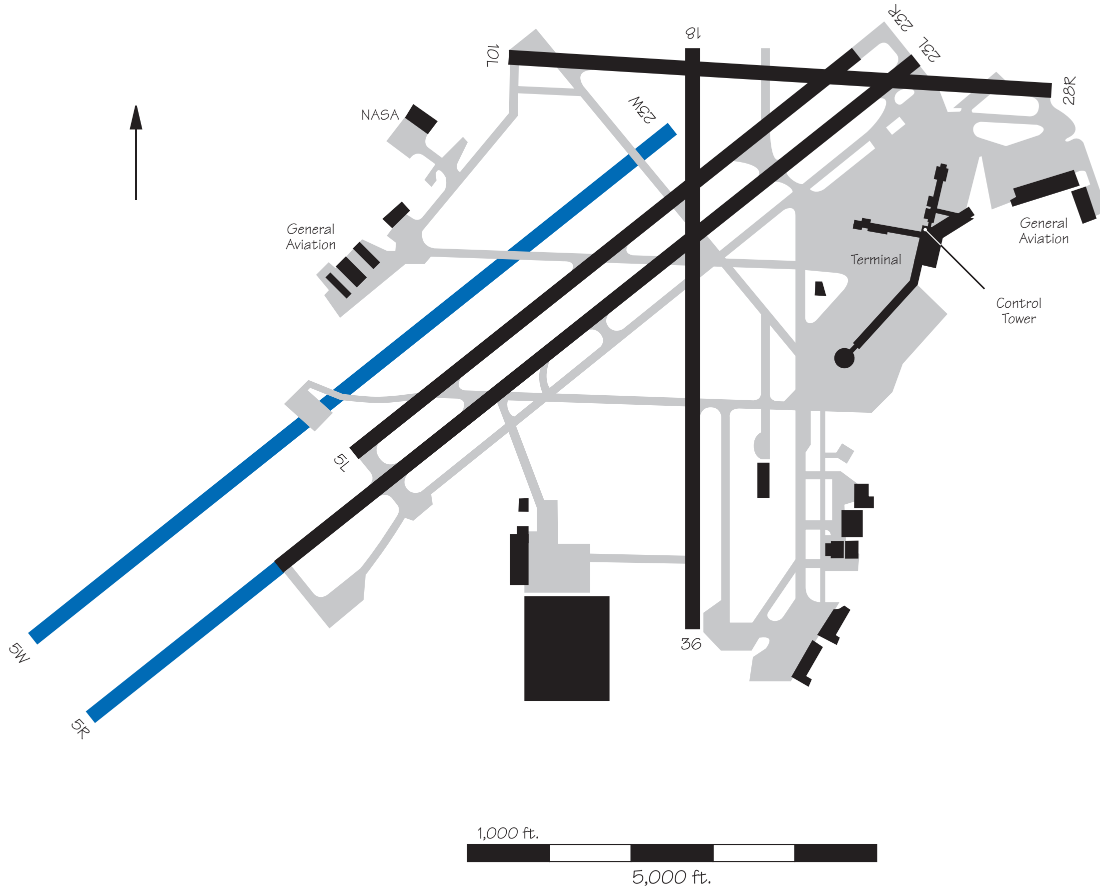


CHS — Charleston AFB International Airport



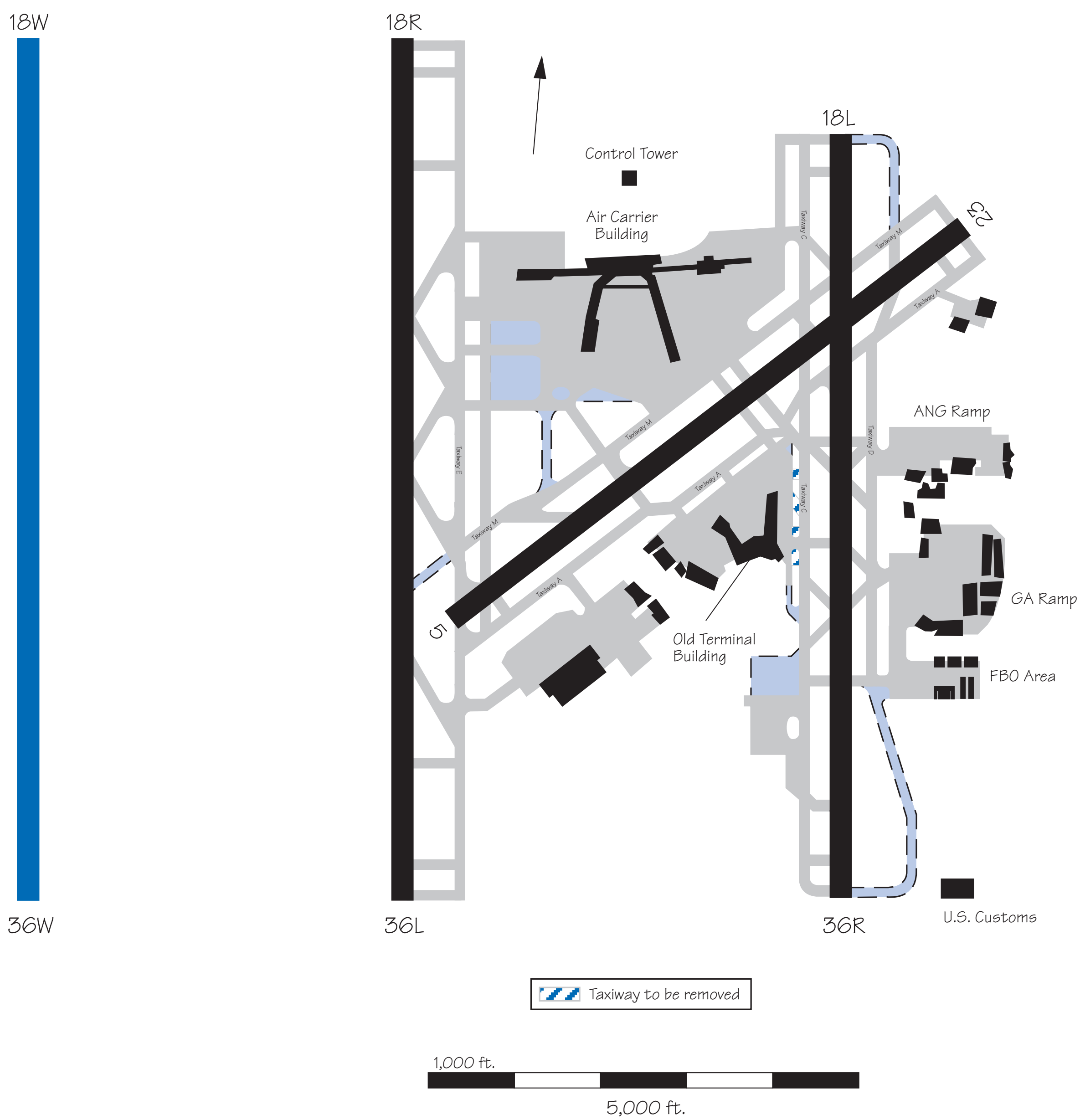
CLE — Cleveland Hopkins International Airport

The Master Plan Update, Phase 1, is conditionally approved. The Airport Layout Plan shows construction of a new Runway 5W/23W that would be 10,950 feet long and 150 feet wide. Construction is expected to be completed in 2000 at a cost of $180 million. Also included in the development plan is an extension of the existing Runway 5R/23L from 7,095 feet to 9,000 feet at an estimated cost of $40 million and conversion of the existing Runway 5L/23R to a parallel taxiway at a cost of $3 million. All of this work is scheduled for completion in 2005.



CLT — Charlotte/Douglas International Airport

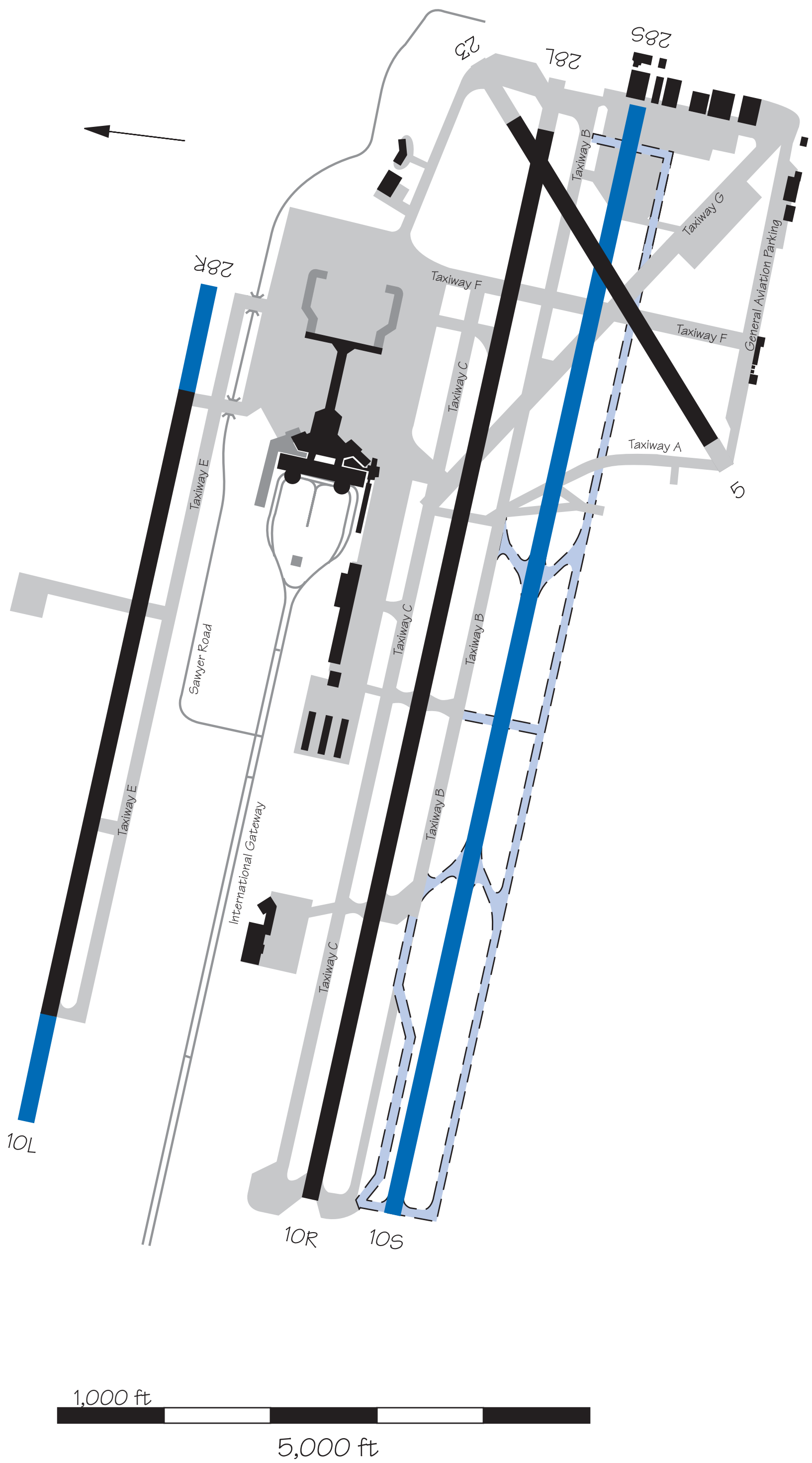
A third parallel 9,000-foot runway, 3,700 feet west of Runway 18R/36L, is being planned. It would permit triple IFR dependent approaches. An Environmental Impact Study is underway and is expected to be completed by mid 1998. Construction is expected to start in late 1998 and be completed in 2001, at an estimated cost of $160 million.



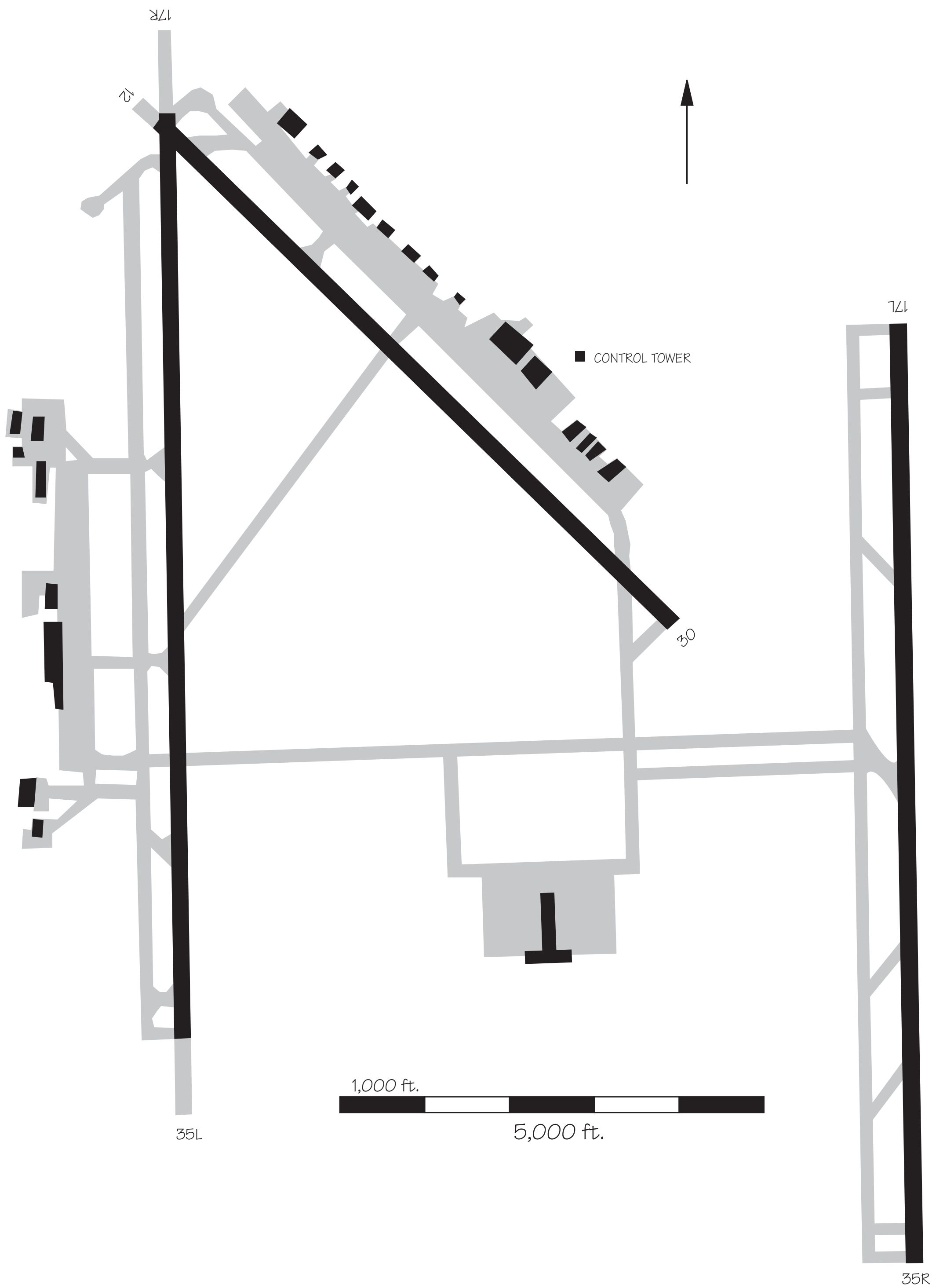
CMH — Port Columbus International Airport

The Airport Layout Plan has been coordinated to show a third parallel Runway 10S/28S constructed 800 feet south of the existing Runway 10R/28L. This runway will be 10,250 feet long and 150 feet wide, with two high speed exits, a 90 degree exit at the center, and a 90 degree bypass taxiway at each end. This would provide a 3,650 foot separation between the proposed Runway 10S/28S and the existing Runway 10L/28R. With the installation of the Precision Runway Monitor (PRM), the existing Runway 10L/28R and the proposed Runway 10S/28S could be used for arrival air traffic. Runway 10R/28L would be used as the departure runway. A 1,000 foot extension to Runwy 28R was completed in late 1996.

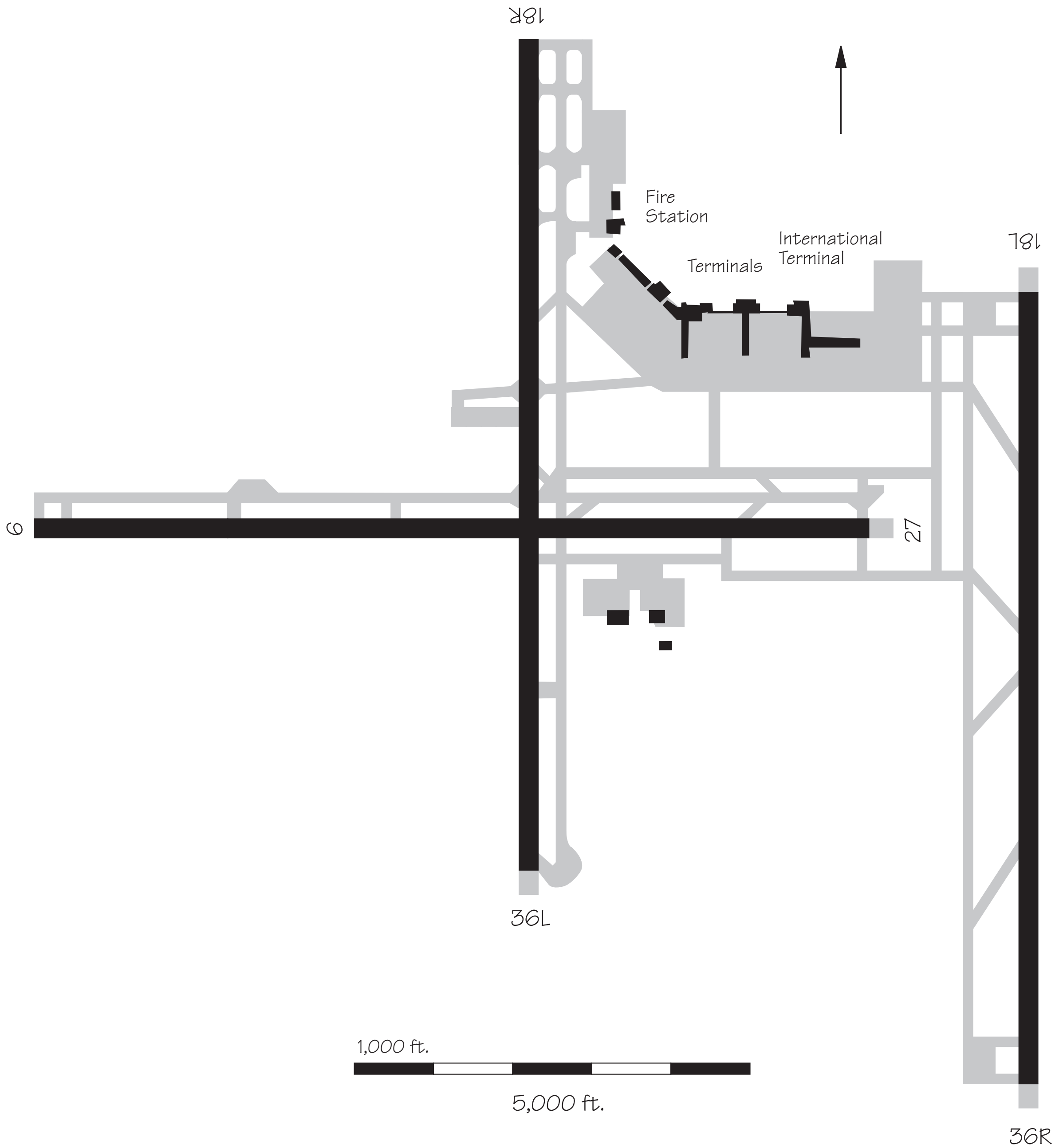
The existing Runway 10L is being extended 1,000 feet and will be completed in 1997. Upon completion, Runway 10L/28R will be 8,000 feet long and 150 feet wide.



COS — Colorado Springs Municipal Airport

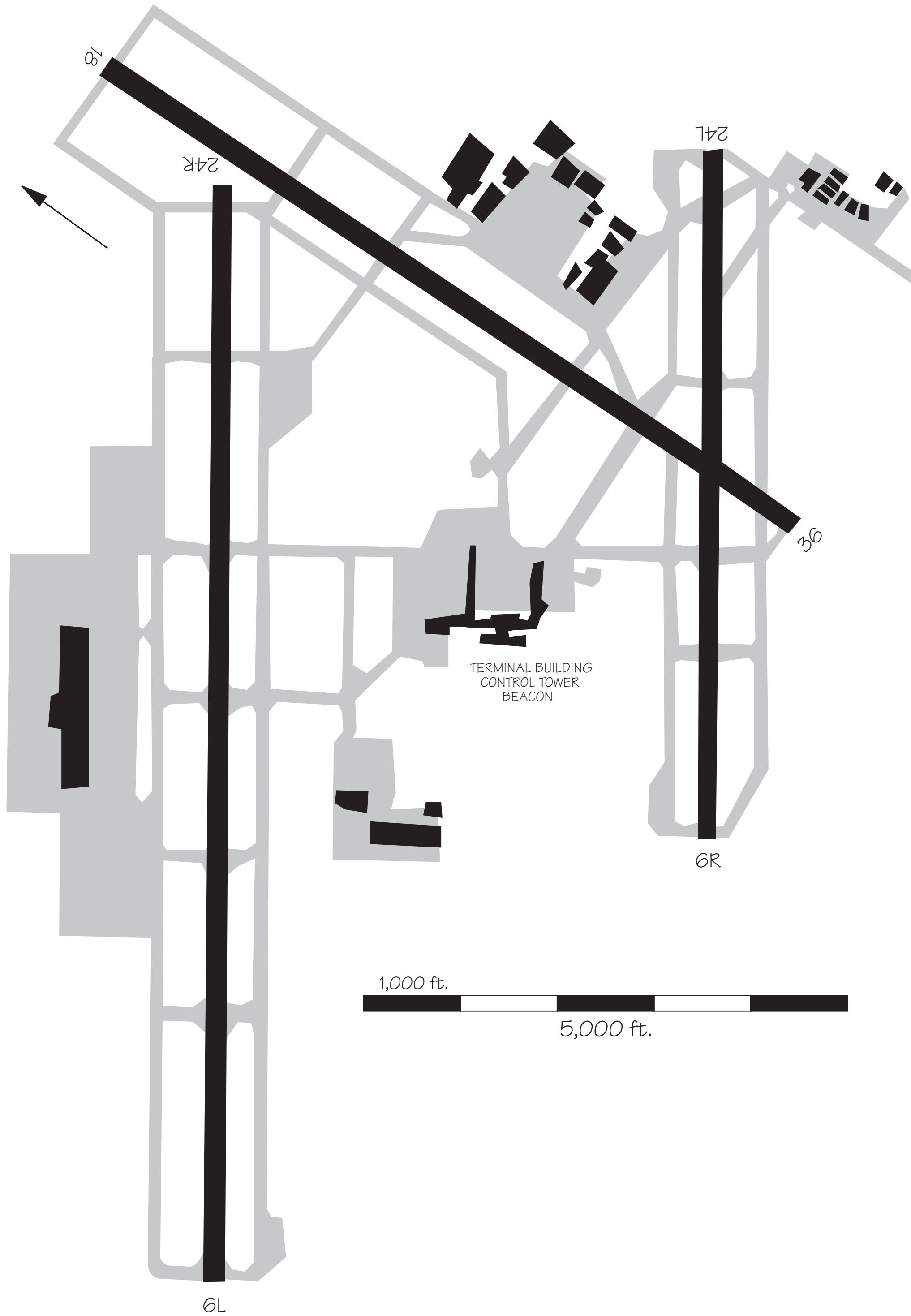


CVG — Greater Cincinnati International Airport

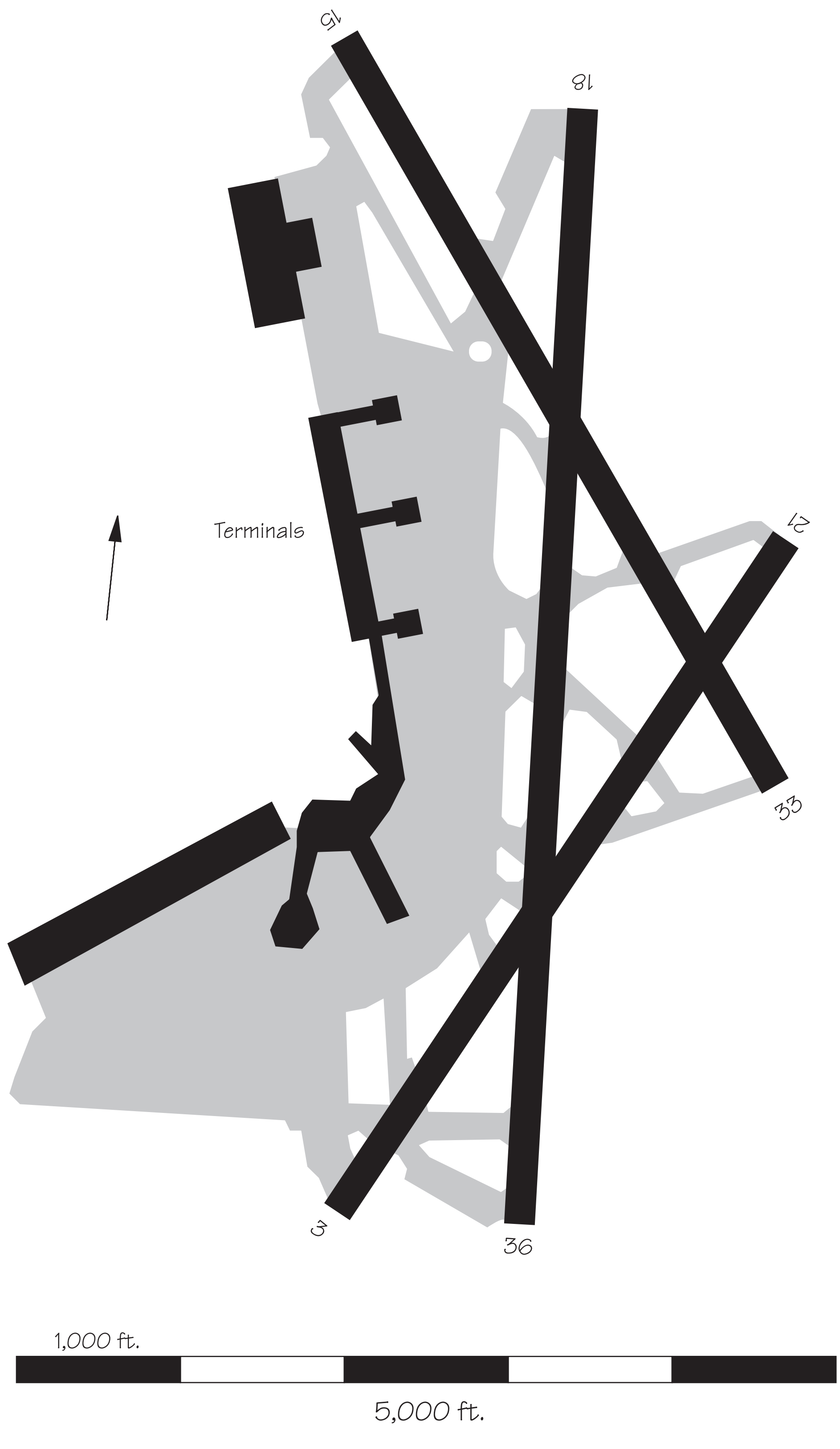


DAL — Dallas-Love Field

DAY — Dayton International Airport

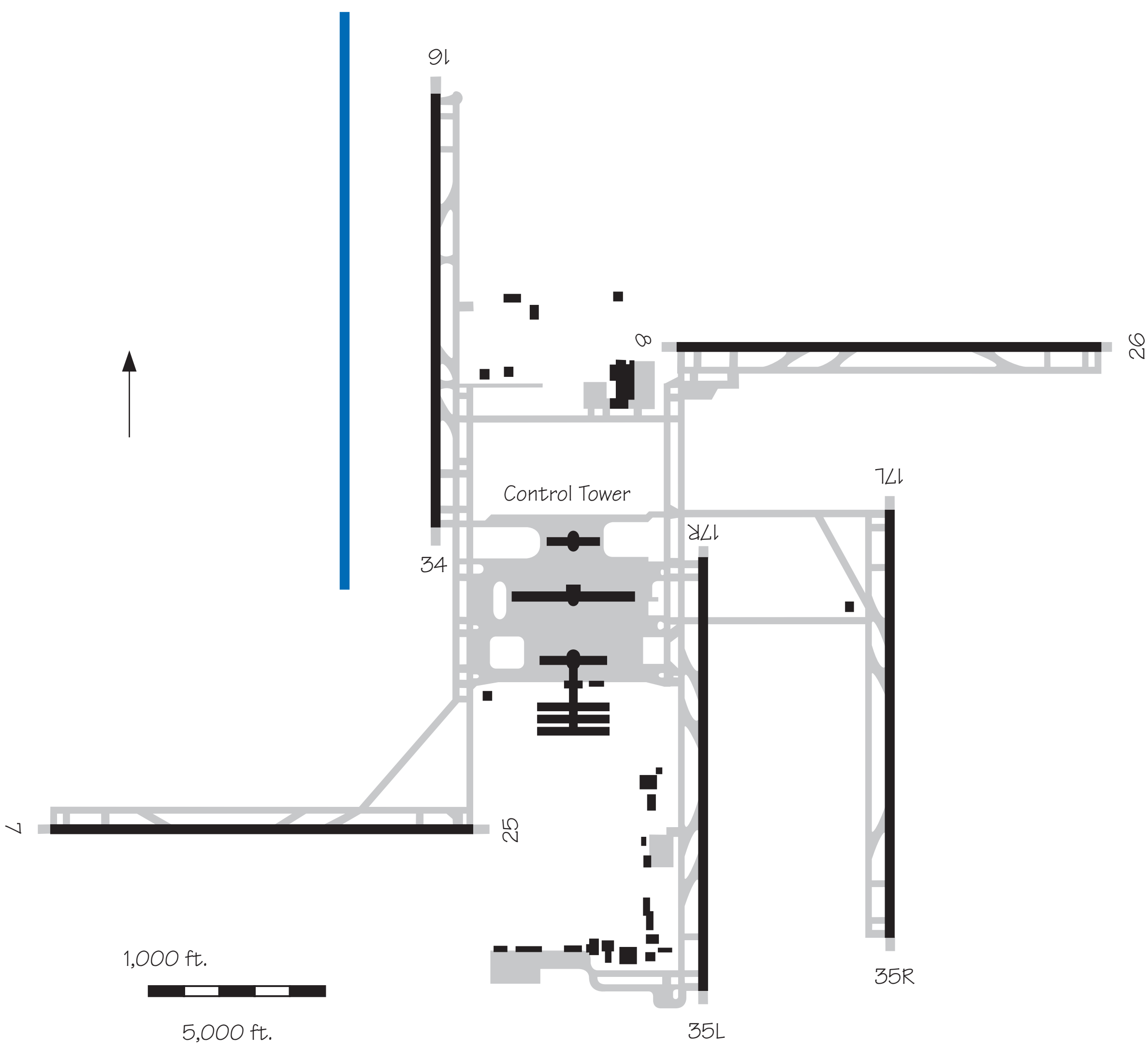


DCA — Washington National Airport



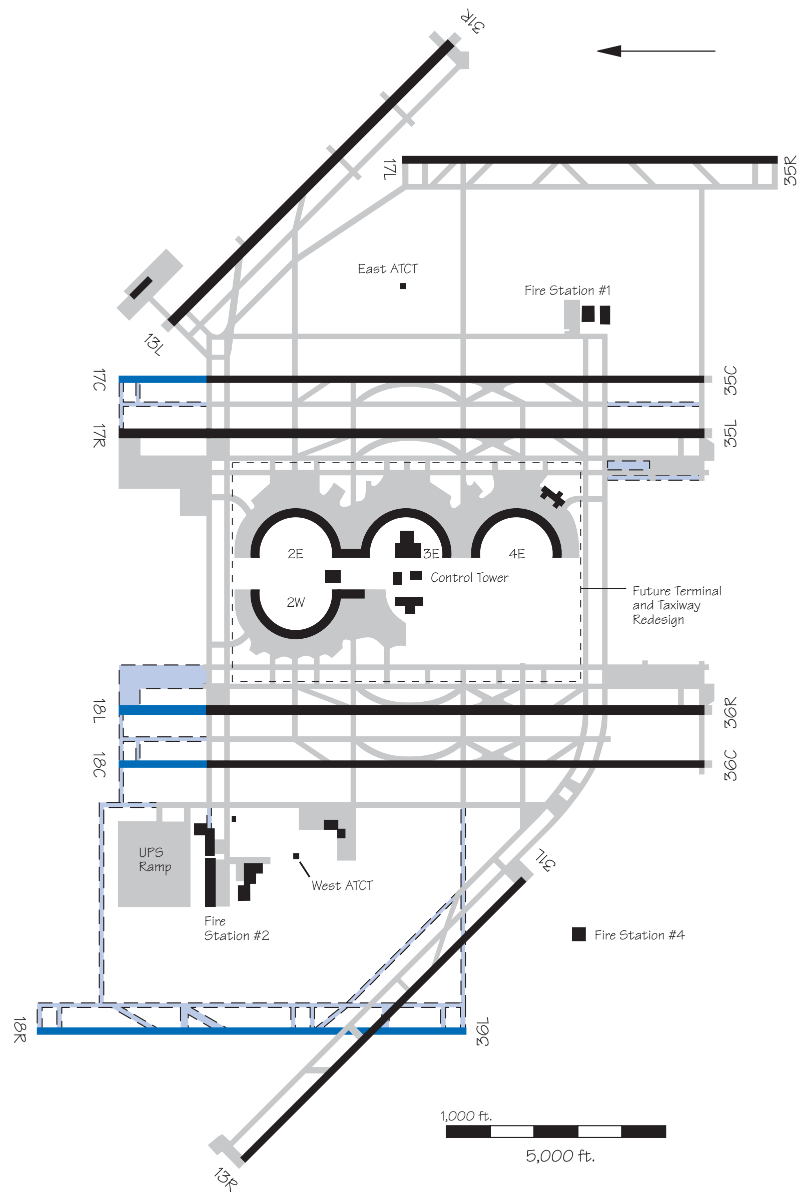
DEN — Denver International Airport

Runway 16R/34L is the last of the six original runways to be built at the new airport. It will be separated 2,600 feet from Runway 16L/34R, and be 16,000 feet in length. The runway is expected to be completed in 2000, at an estimated cost of $75 million.



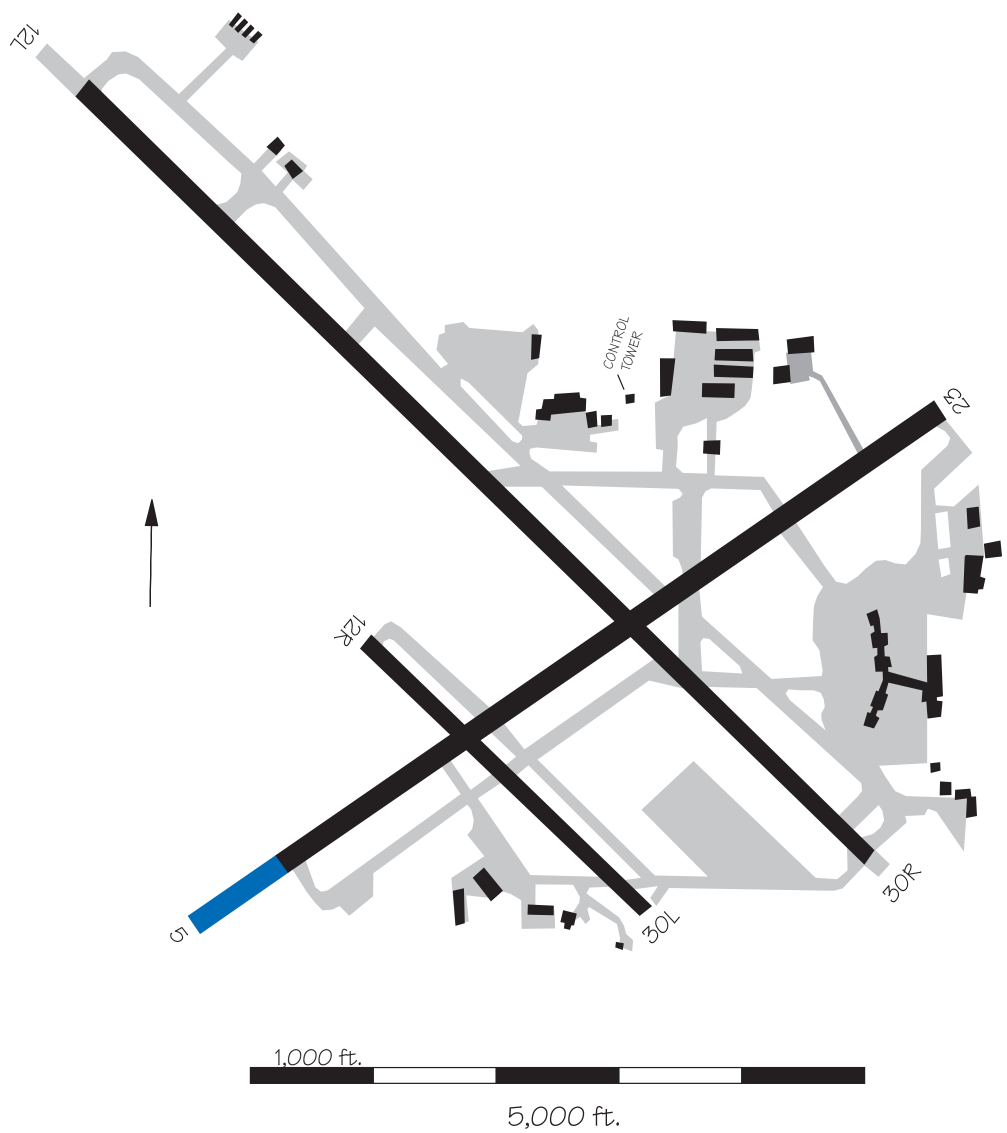
DFW — Dallas-Fort Worth International Airport

Proposed 2,000-foot extensions to all of the north/south parallel runways will provide an overall length of 13,400 feet for each. Environmental assessments for the extension to Runway 17C/35C, Runway 18L/36R, and Runway 18R/36L are expected to be completed in 1997. The estimated cost of each extension is $25 million. A terminal expansion program is underway that will add five new jet departure gates to the soughside of Terminal 2W; provide baggage and passenger connections to Terminal 2E; and renovate a portion of Terminal 2W. The total cost of this program is approximately $100 million and is scheduled for completion in 1999. Construction on the west runway, Runway 18R/36L, will begin when warranted by aviation demand. It could be available as early as 2003. The estimated cost is $268 million. It will be located 5,800 feet west of Runway 18R/36L (to be renamed 18C/36C). Runway 18R/36L may be constructed in phases, with the first phase a 6,000 foot runway located north of Runway 13R/31L. The second phase extension to 9,760 feet would intersect and continue south of Runway 13R/31L. The addition of Runway 18R/36L will allow DFW to accomodate quadruple simultaneous precision instrument approaches.



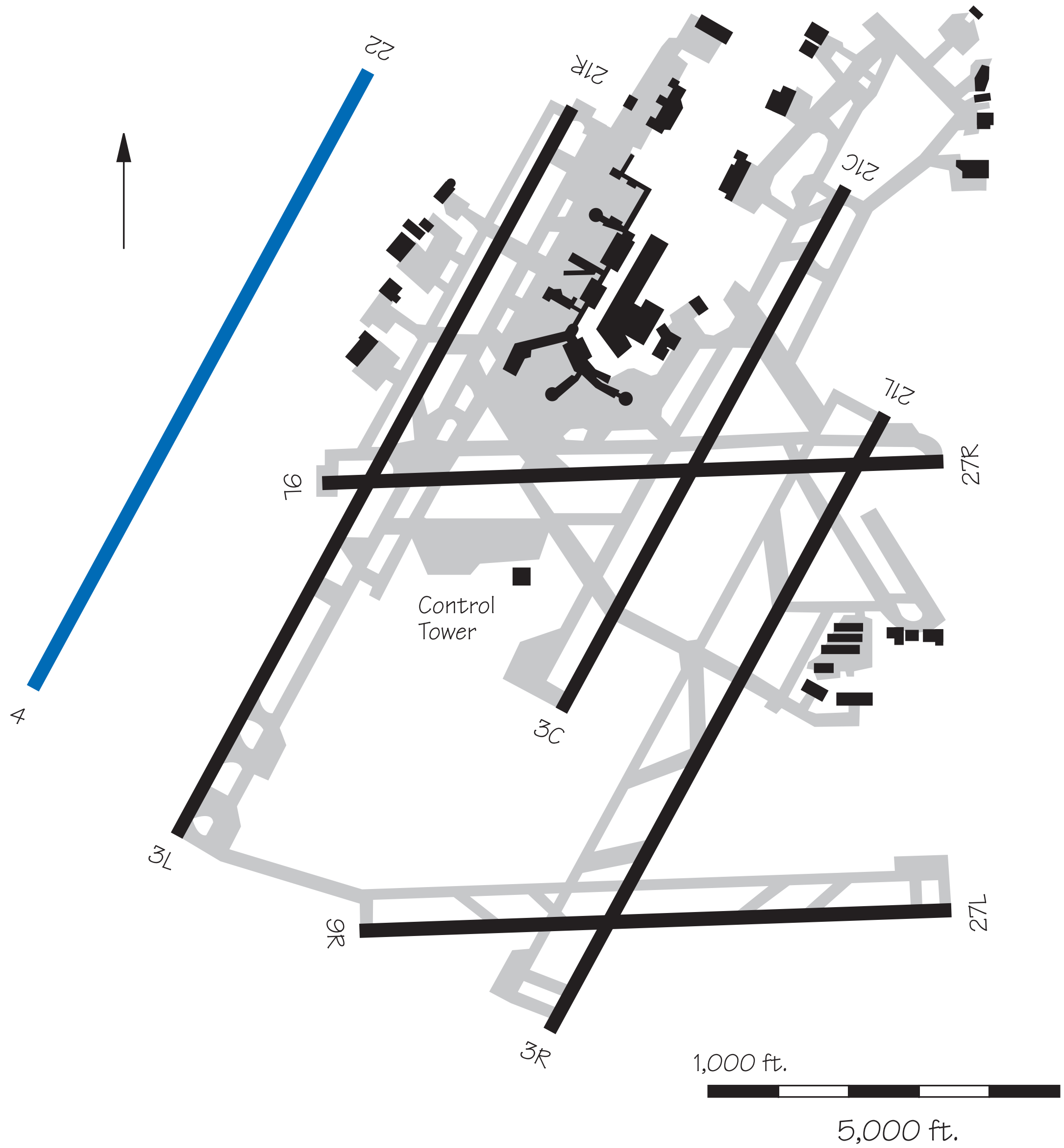
DSM — Des Moines International Airport

An Environmental Impact Study was recently completed on a southwest extension of Runway 5/23. Construction is planned to begin in 1997, and is expected to be completed in 2001. Cost for construction is estimated at $28 million, with an estimated additional $20 million for road relocation.



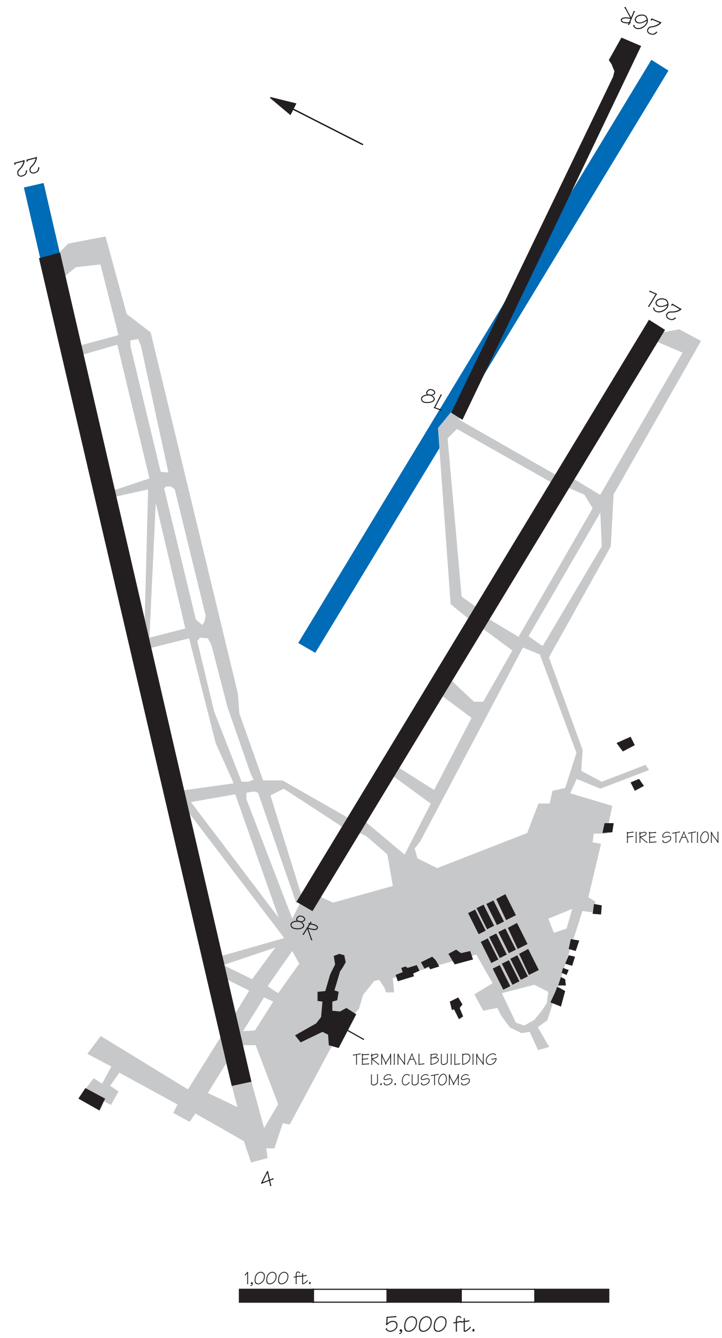
DTW — Detroit Metropolitan Wayne County Airport

A fourth north-south parallel, Runway 4/22 is planned. Construction is expected to begin in 1999 and should be completed in 2001. The estimated cost of construction is $116.5 million. This runway could potentially permit triple IFR arrivals with one dependent and one independent pairing. An environmental assessment was submitted in September 1989, and a record of decision was issued in March 1990. Land acquisition is currently in progress.



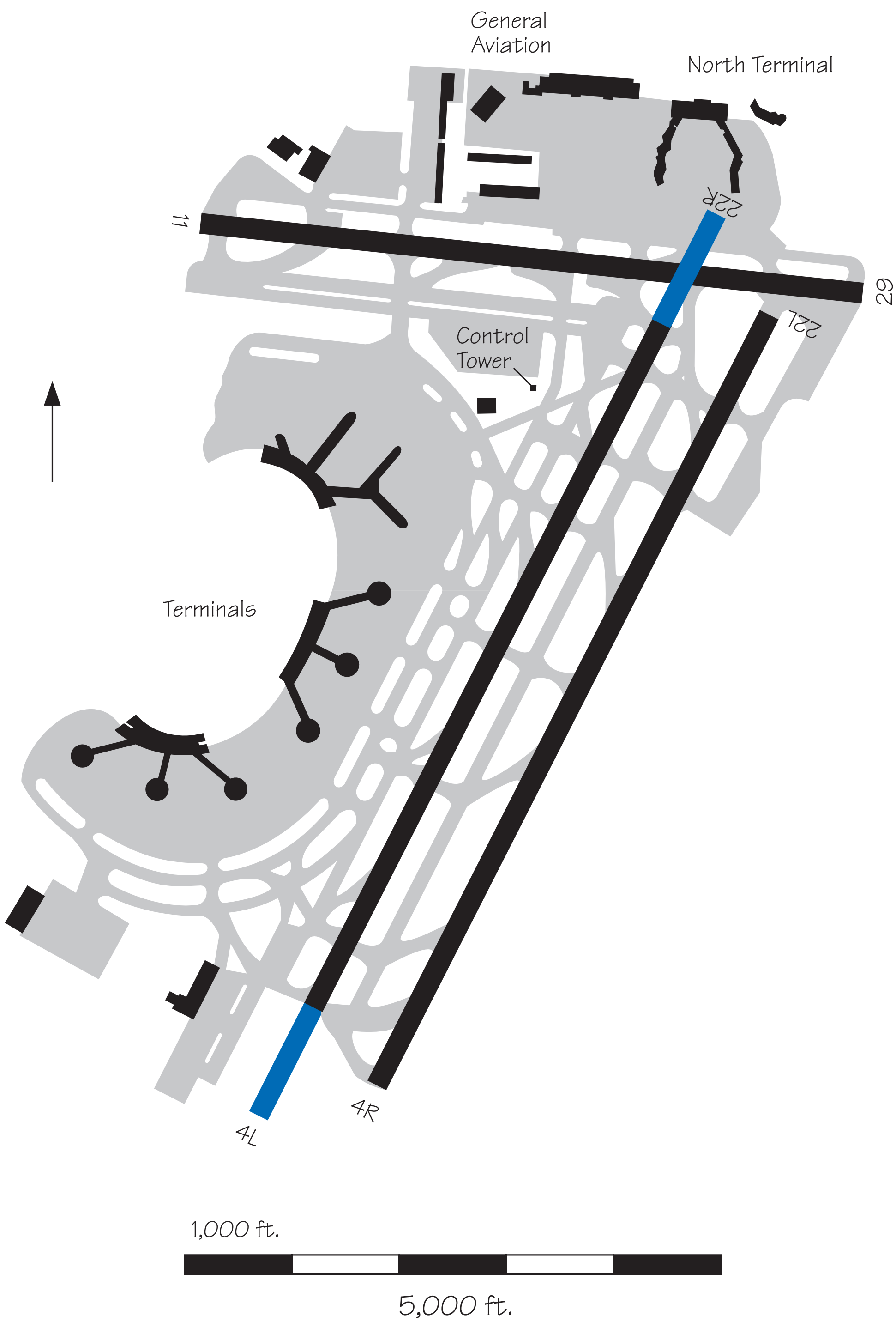
ELP — El Paso International Airport

A new parallel Runway 8L/26R is shown on the current Airport Layout Plan for the year 2010 plus time frame. Estimated cost would be $20-30 million. In addition, a 1,000 ft. extension to Runway 22 is included in the currently approved Passenger Facility Charge for the year 2000. Estimated cost would be $8 million.



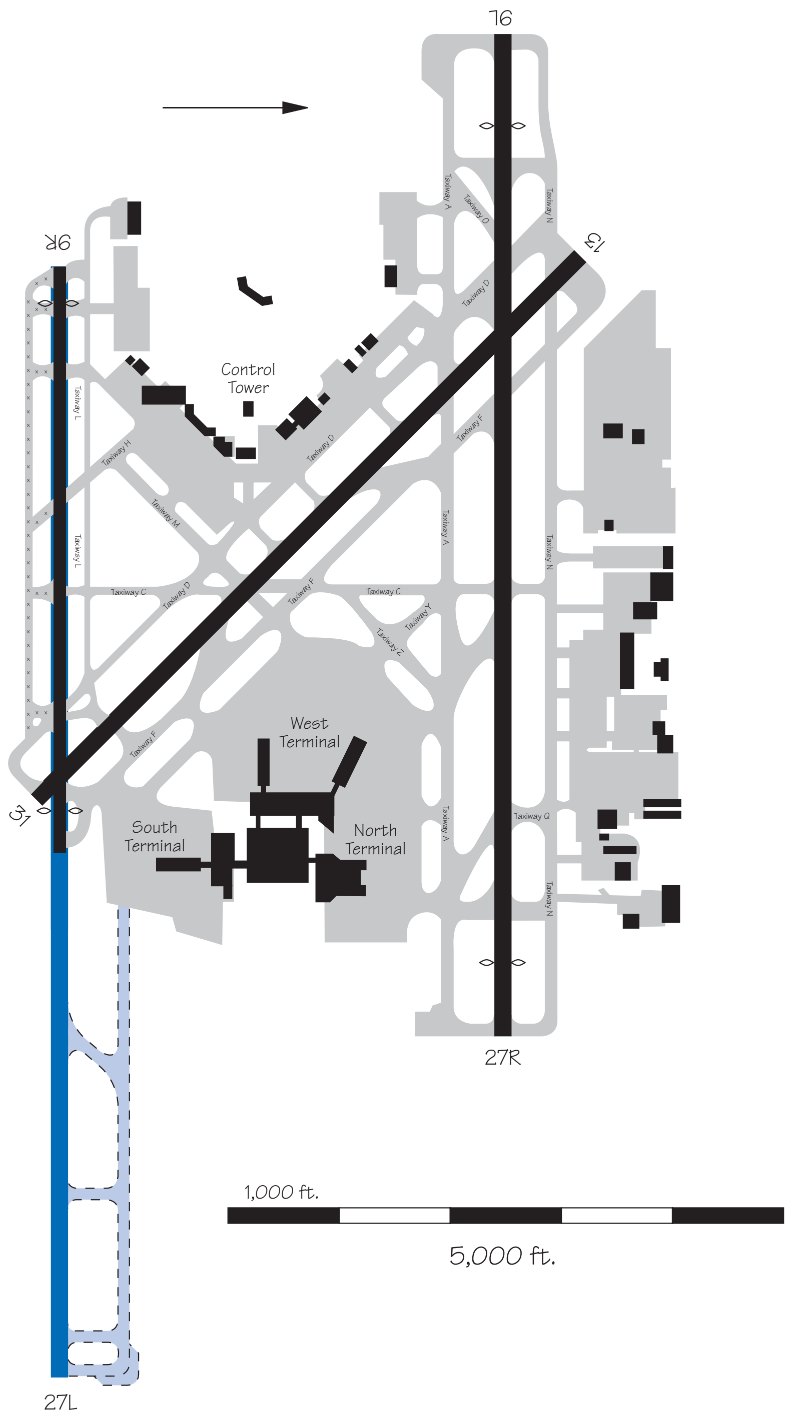
EWR — Newark International Airport

An extension to Runway 4L/22R is in the preliminary planning stage. The estimated operational date is 2000.



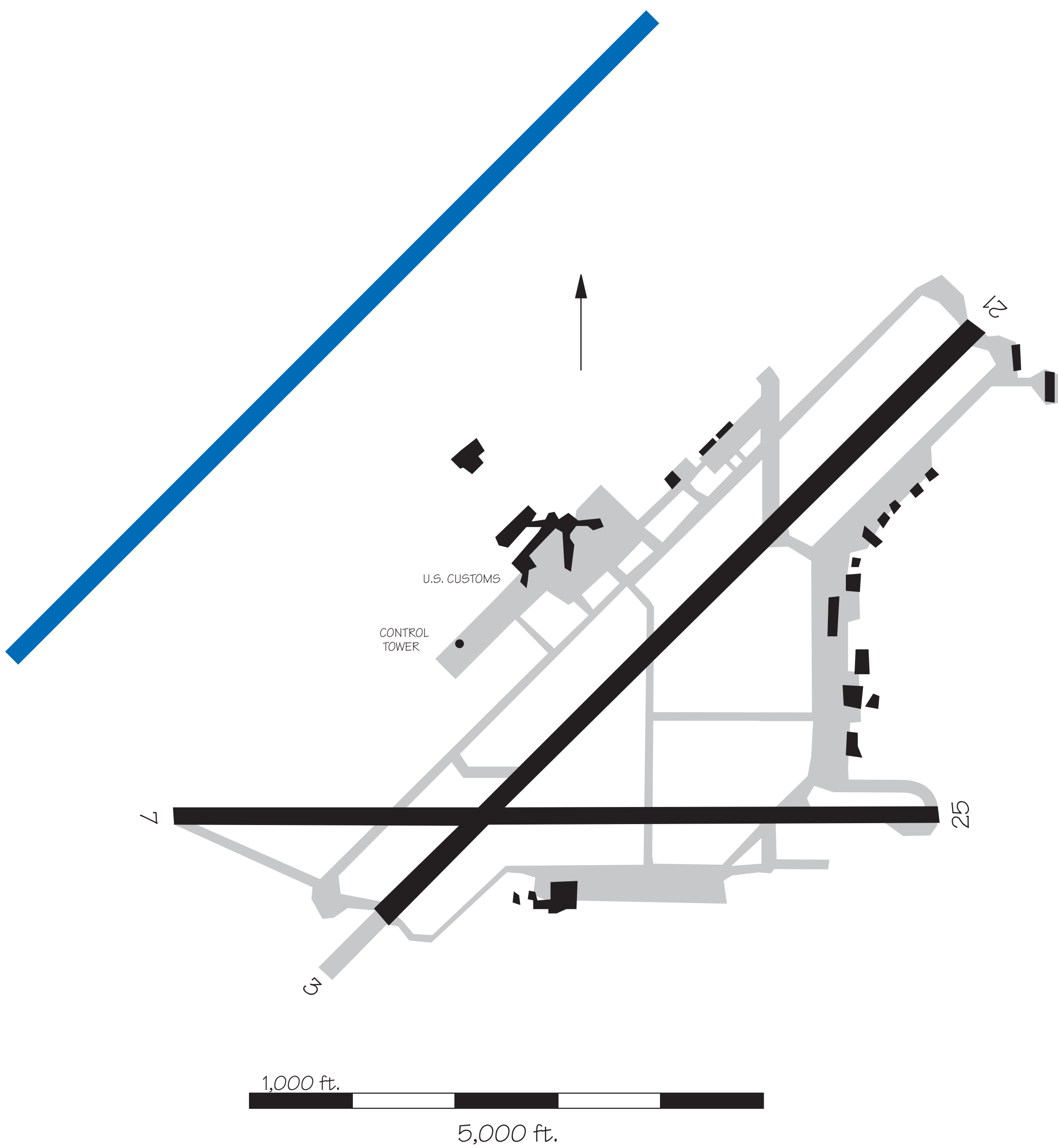
FLL — Fort Lauderdale-Hollywood International Airport

An extension of the short parallel Runway 9R/27L to 9,000 feet is planned to provide the airport with a second parallel air carrier runway. Construction is expected to begin in 2000. The estimated cost of construction is $300 million. The anticipated operational date is 2003. An EIS is underway and expected to be completed in 1998.



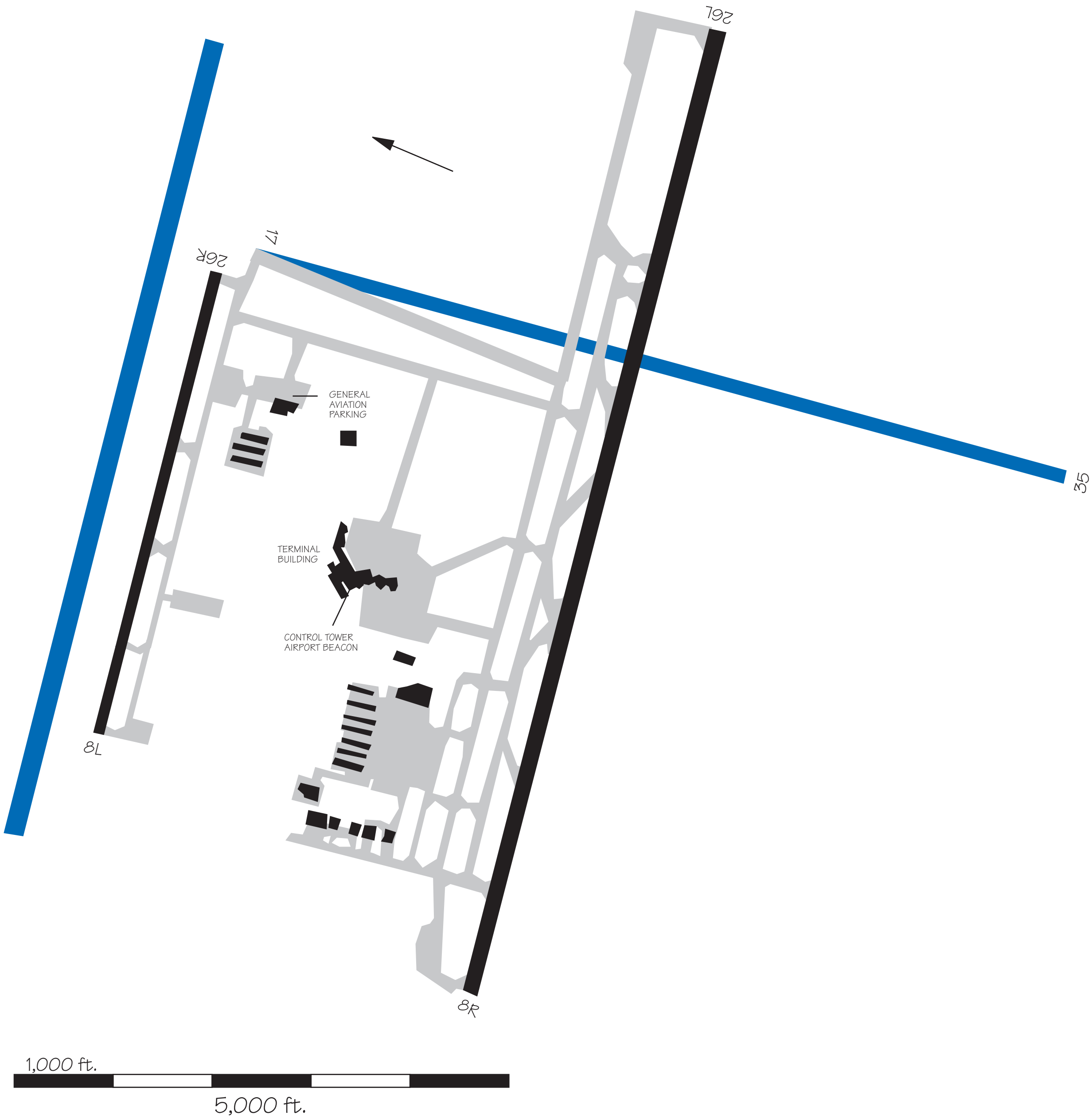
GEG — Spokane International Airport

Future projects include the construction of a new parallel Runway 3L/21R. The new runway will be 8,800 feet long by 150 feet wide and will be separated from Runway 3R/21L by 4,300 feet. This would enable independent parallel operations, doubling hourly IFR arrival capacity. The estimated cost of construction of the new runway is approximately $11 million. The runway may be completed by 2010.



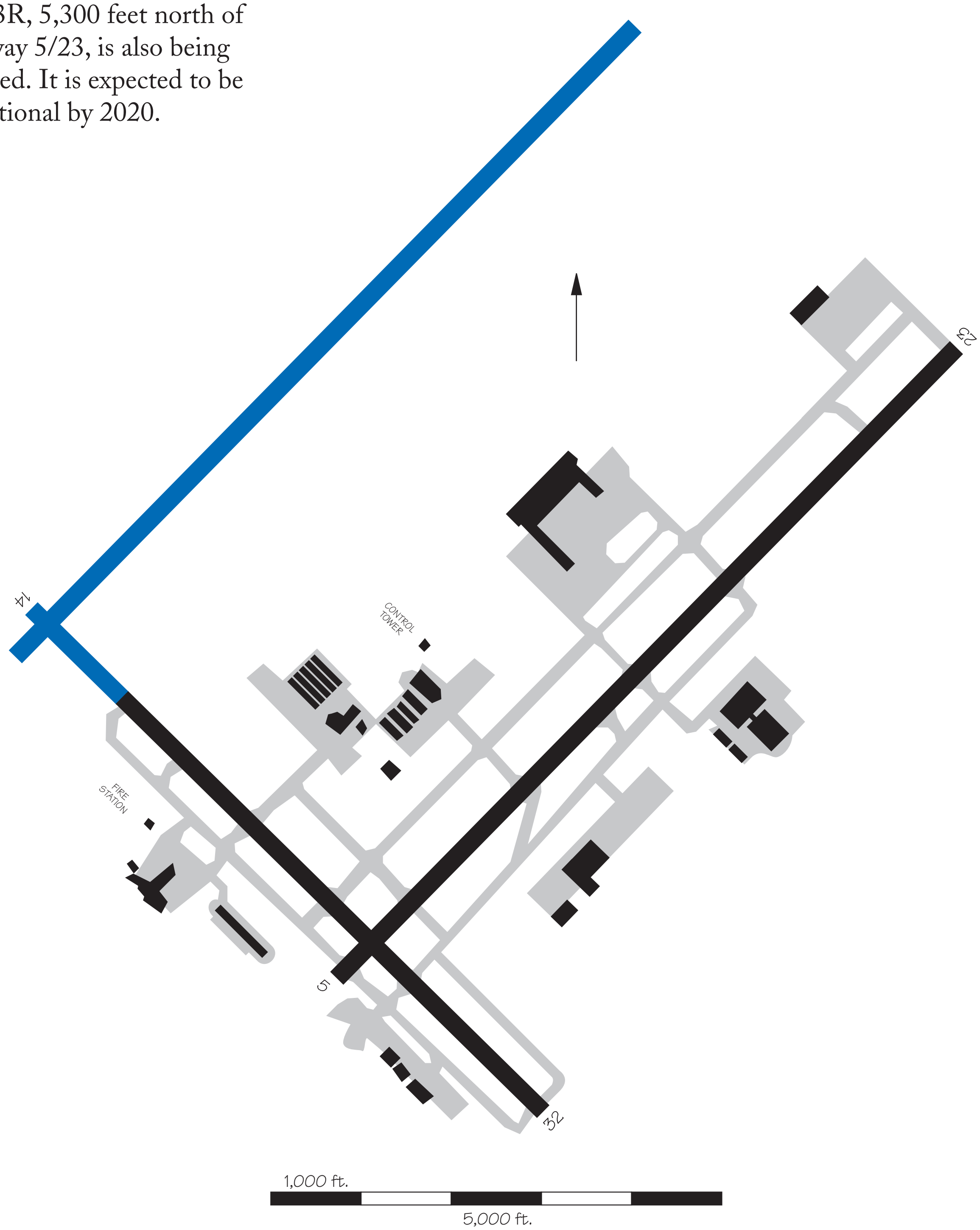
GRR — Grand Rapids Kent County International Airport

An extension to 8,500 feet and realignment for the cross-wind Runway 18/36 (17/35) is under construction. Estimated cost is $58 million. The run-way will provide wind cover-age, noise relief, and reduce winter weather related delays by providing a second air carrier runway. Construction is expected to be complete in 1997. A new 7,000 foot parallel Runway 8L/26R is planned for future develop-ment. The current 8L/26R would be converted into a taxiway at that time.



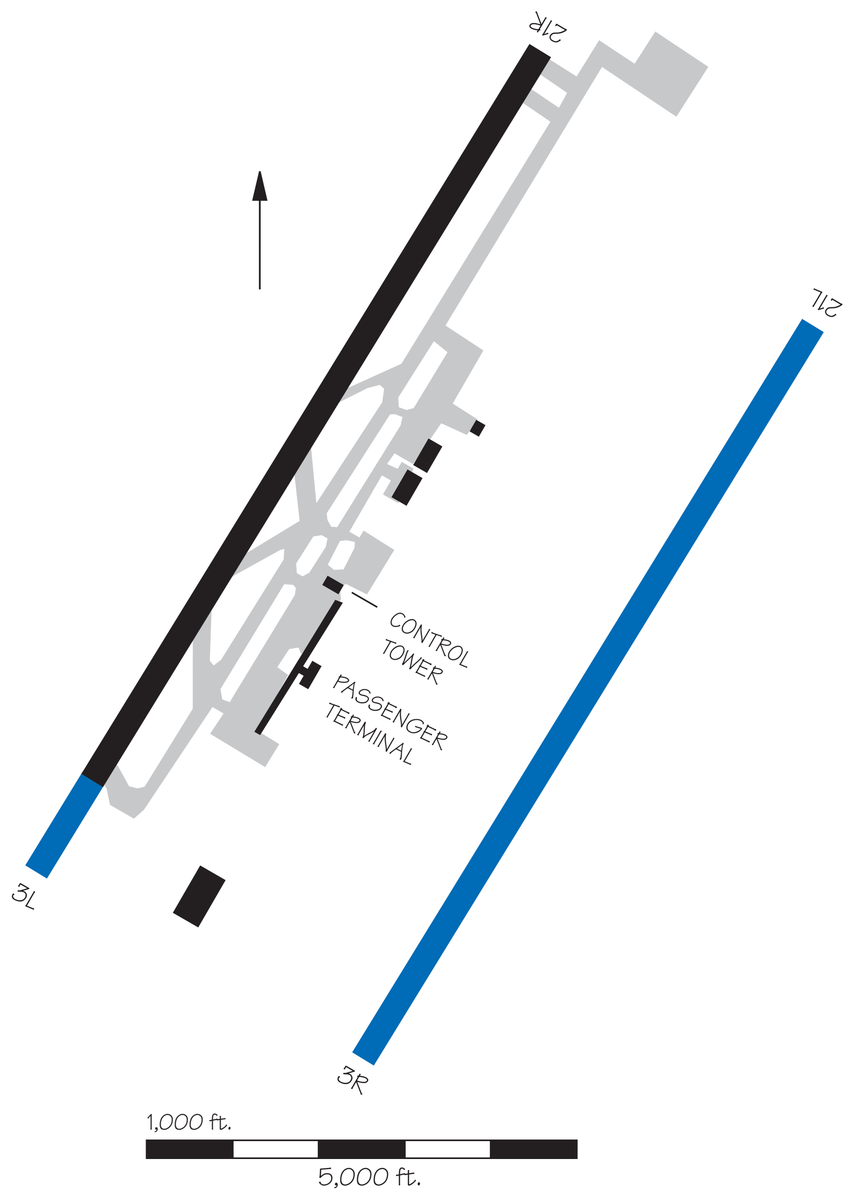
GSO — Greensboro Piedmont Triad International Airport

An extension of Runway 14/32 is planned. It is expected to be operational by 2004, at a cost of $27 million. Construction of a new parallel Runway 5L/23R, 5,300 feet north of Runway 5/23, is also being planned. It is expected to be operational by 2020.

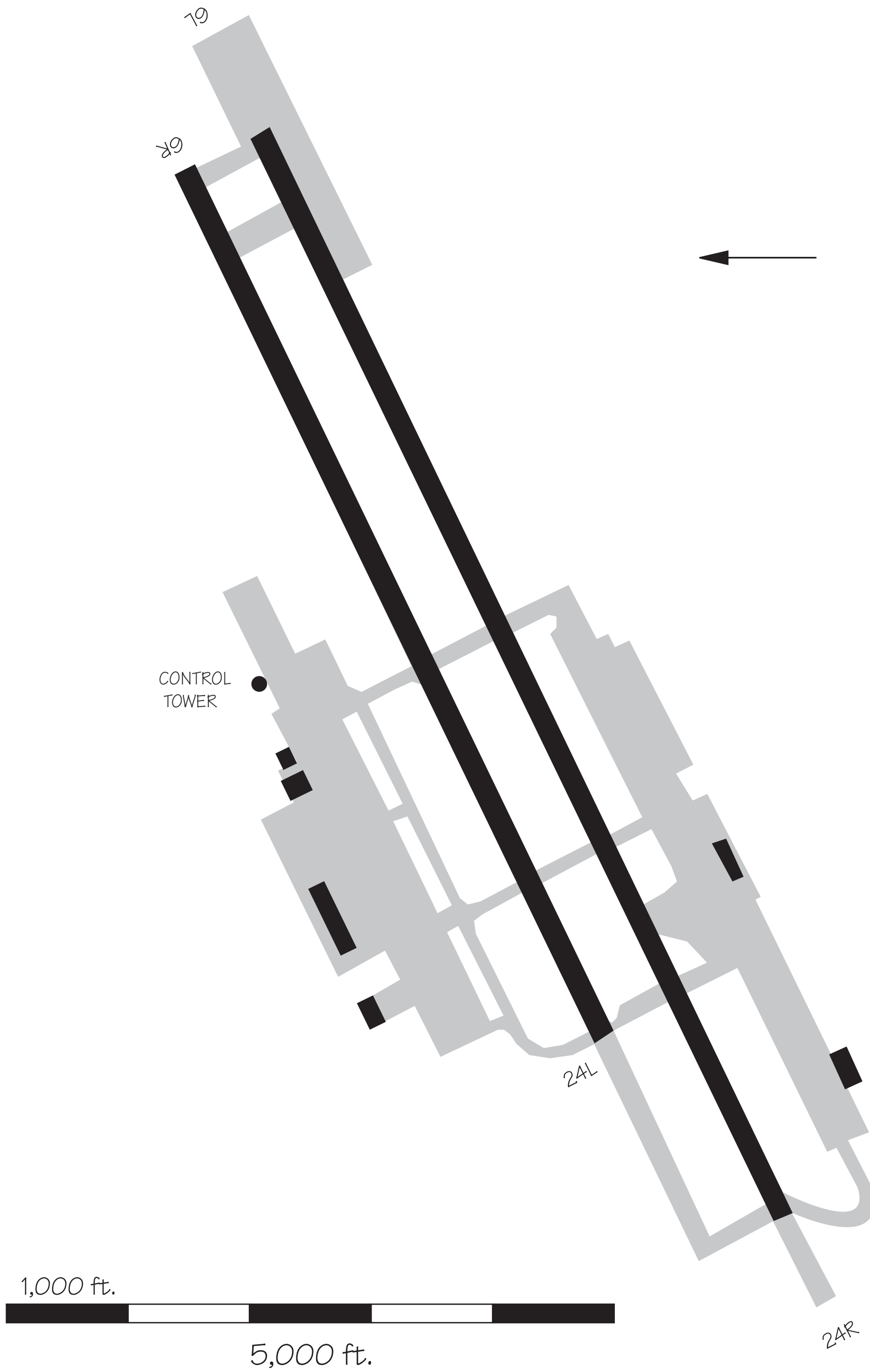


GSP — Greer Greenville-Spartanburg Airport

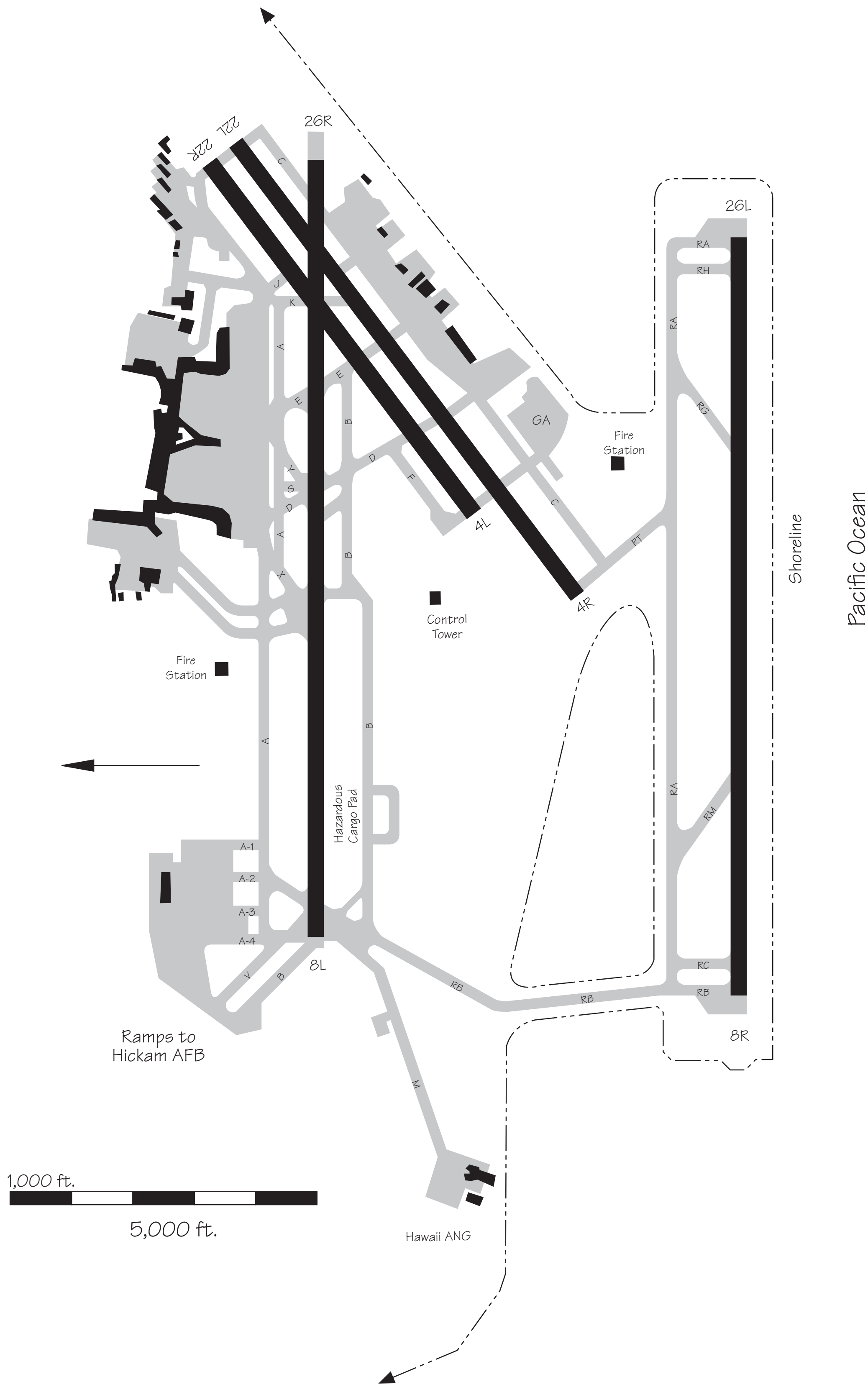
A new parallel runway, Runway 3R/21L, is anticipated in 2010 at an estimated cost of $65 million. Presently, its planned length is 8,200 feet with a 4,300 foot separation from Runway 3/21. This would potentially double hourly IFR arrival capacity Also, an extension of Runway 3L/21R to 11,000 ft is expected to be completed by 1999 at a cost of $34.1 million.



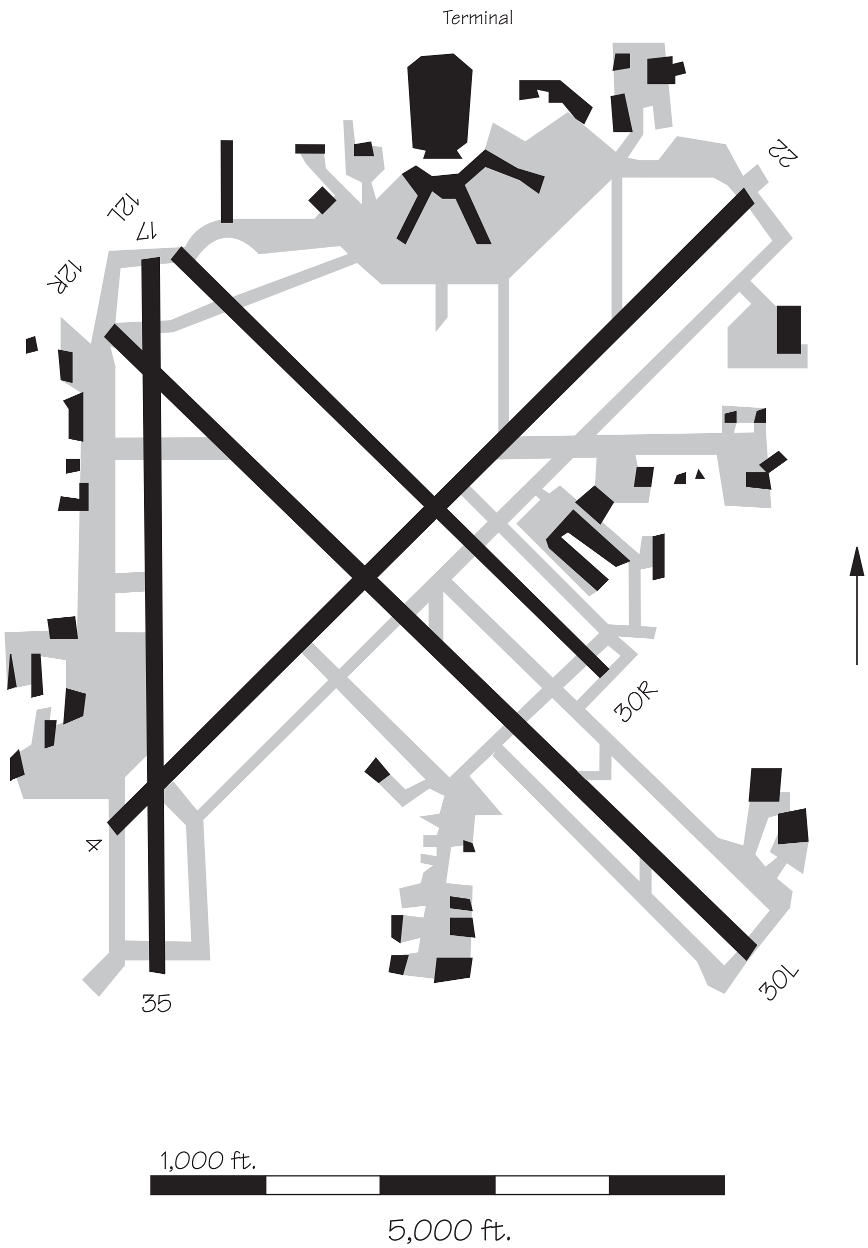
GUM — Guam International Airport



HNL — Honolulu International Airport

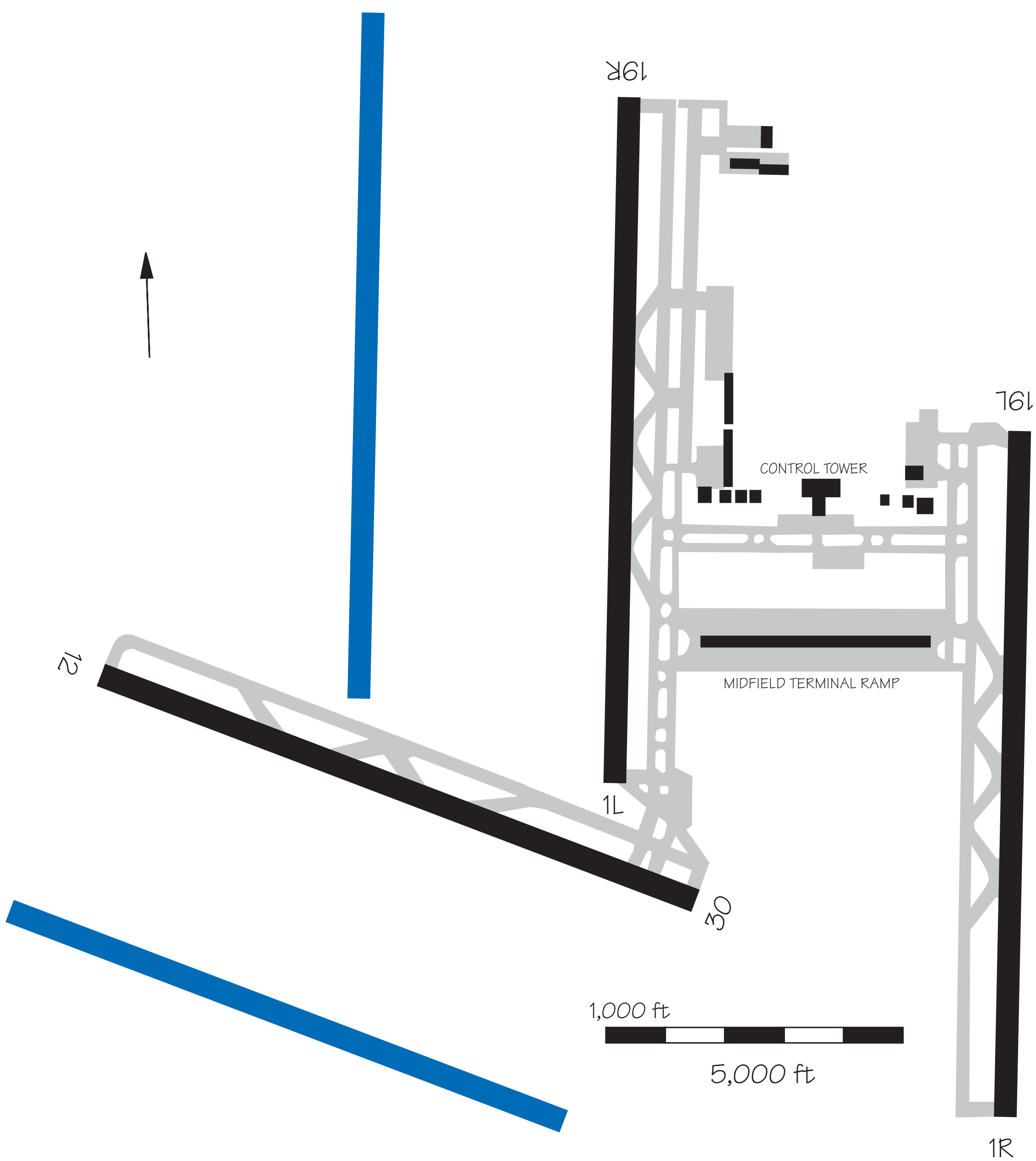


HOU — Houston William P. Hobby Airport



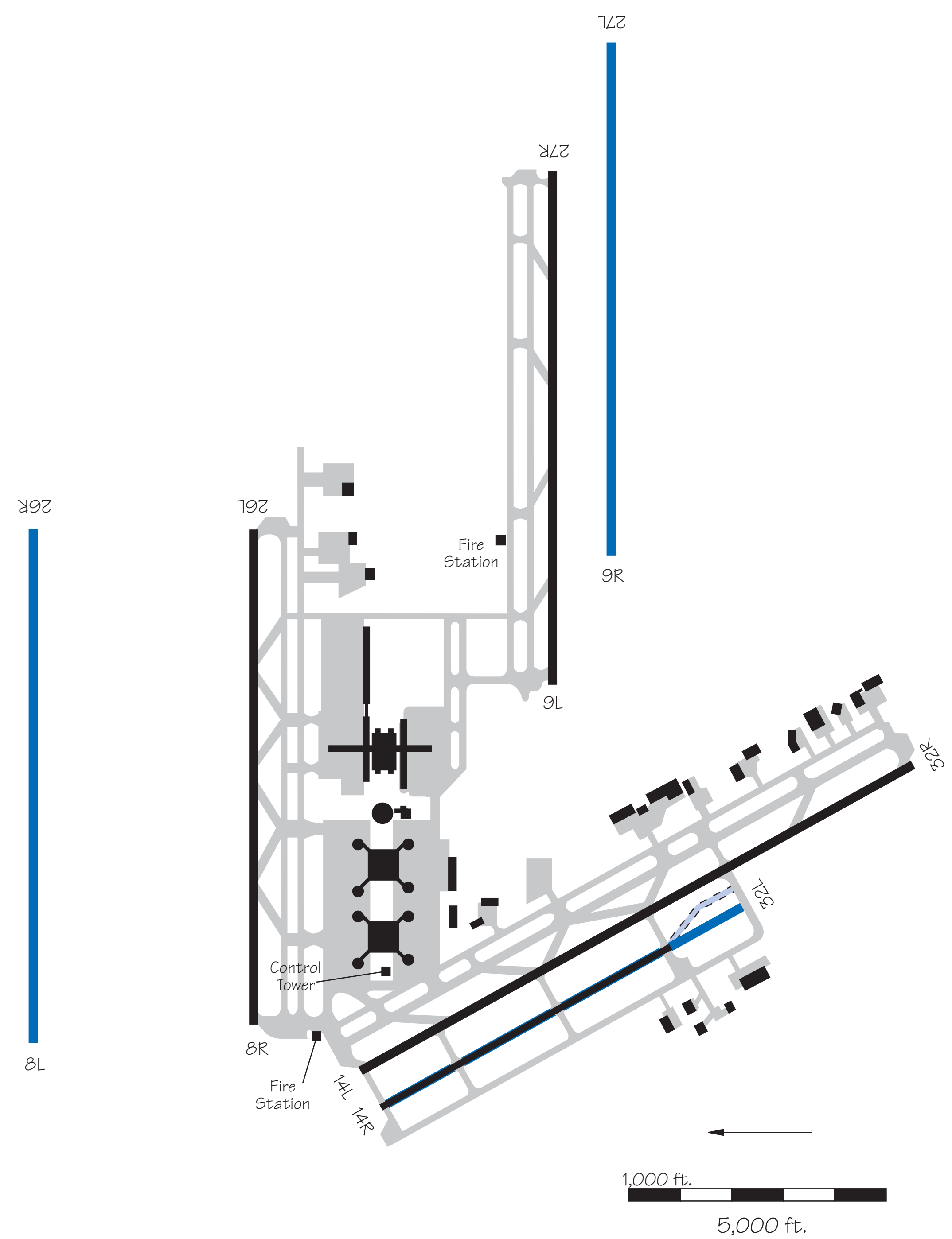
IAD — Washington Dulles International Airport

Two new parallel runways are under consideration. A north-south parallel, Runway 1W/19W, would be located 4,300 feet west of the existing parallels and north of Runway 12/30. Estimated opening date is 2009. This could provide triple independent parallel approaches, if they are approved. A second parallel Runway 12R/30L has been proposed for location 4,300 feet southwest of Runway 12/30. The runway is expected to be completed by 2010.

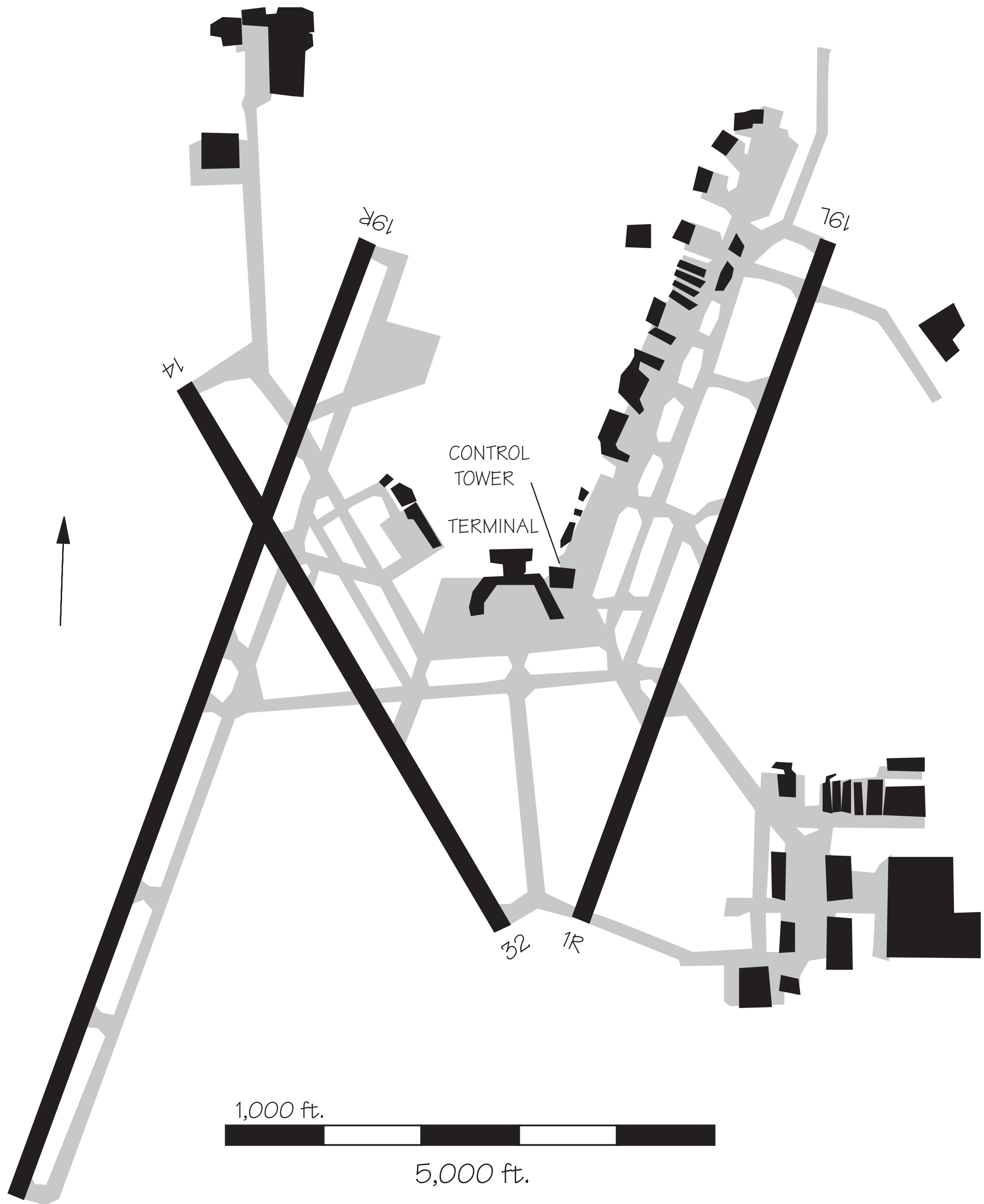


IAH — George Bush International Airport

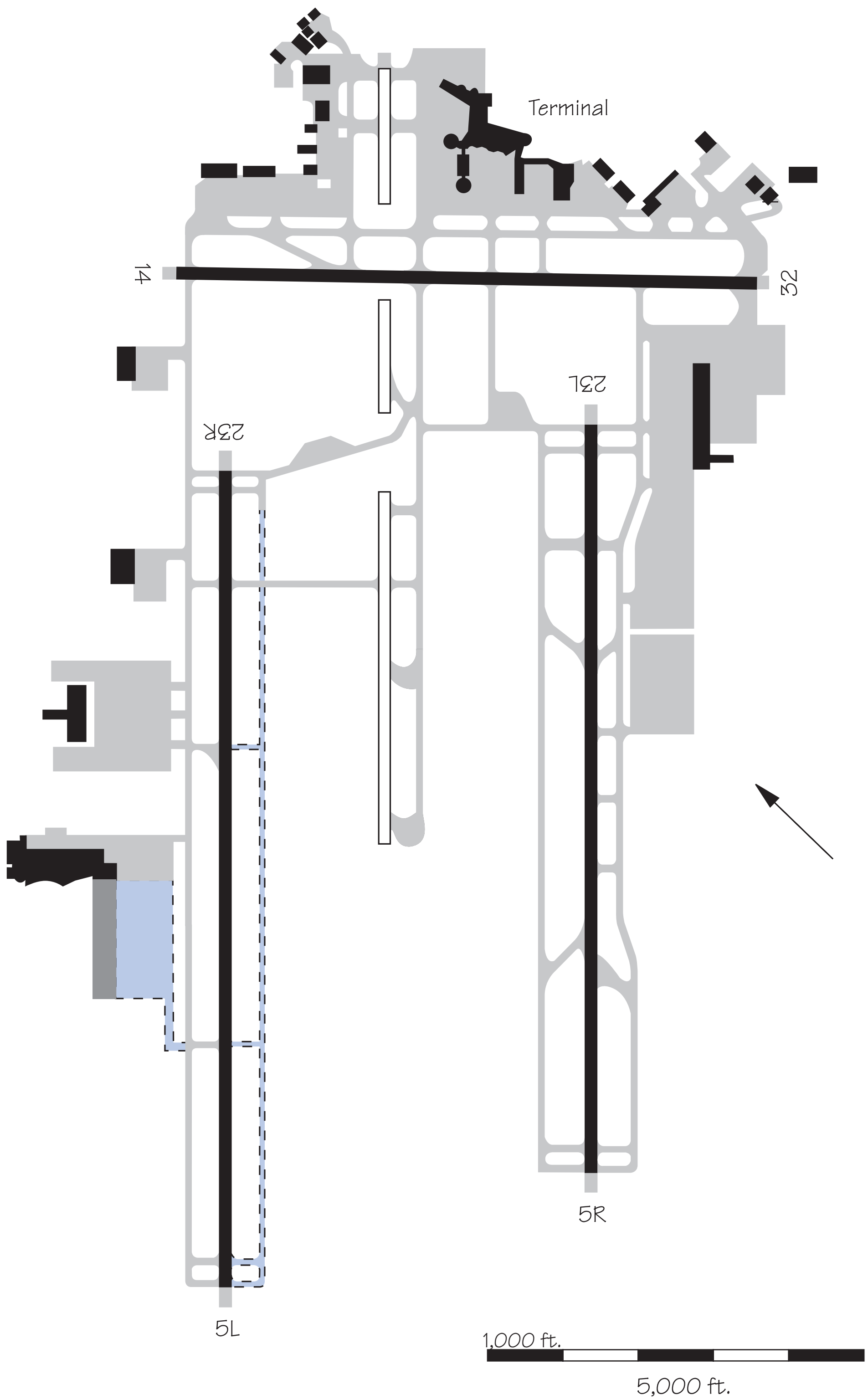
An $8 million 2,000-foot extension to Runway 14R/32L is planned for the year 2000. A new Runway 8L/26R is planned to be parallel to, and north of, the existing Runway 8/26. Commissioning is tentatively scheduled for the year 2002. Runway 8L/26R, in conjunction with Runways 9/27 and 8/26, has the potential to support triple IFR approaches, if approved. Another new runway, parallel to and south of Runway 9/27, is also planned in the distant future. Construction is expected to cost $95 million for Runway 8L/26R.



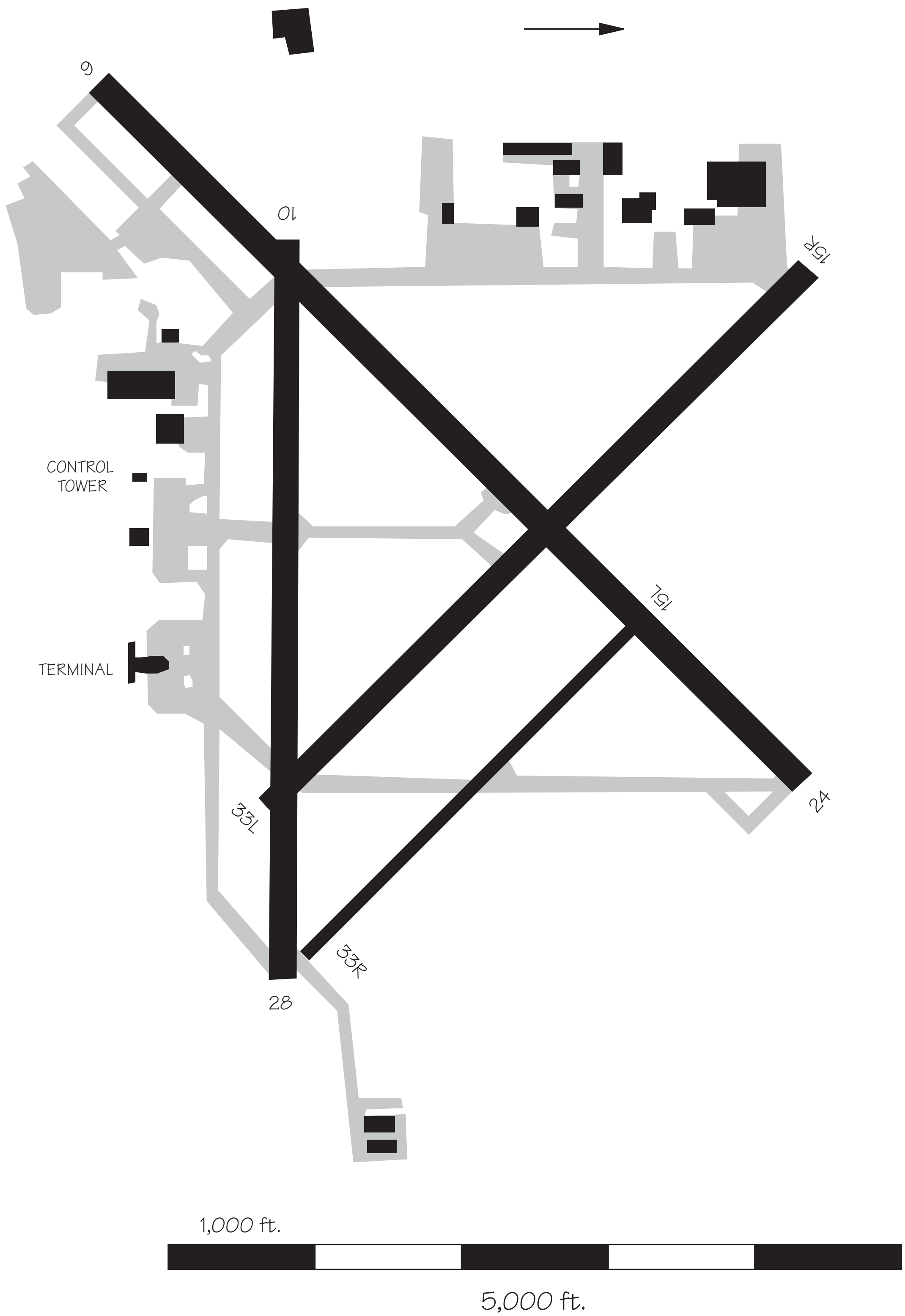
ICT — Wichita Mid-Continent Airport



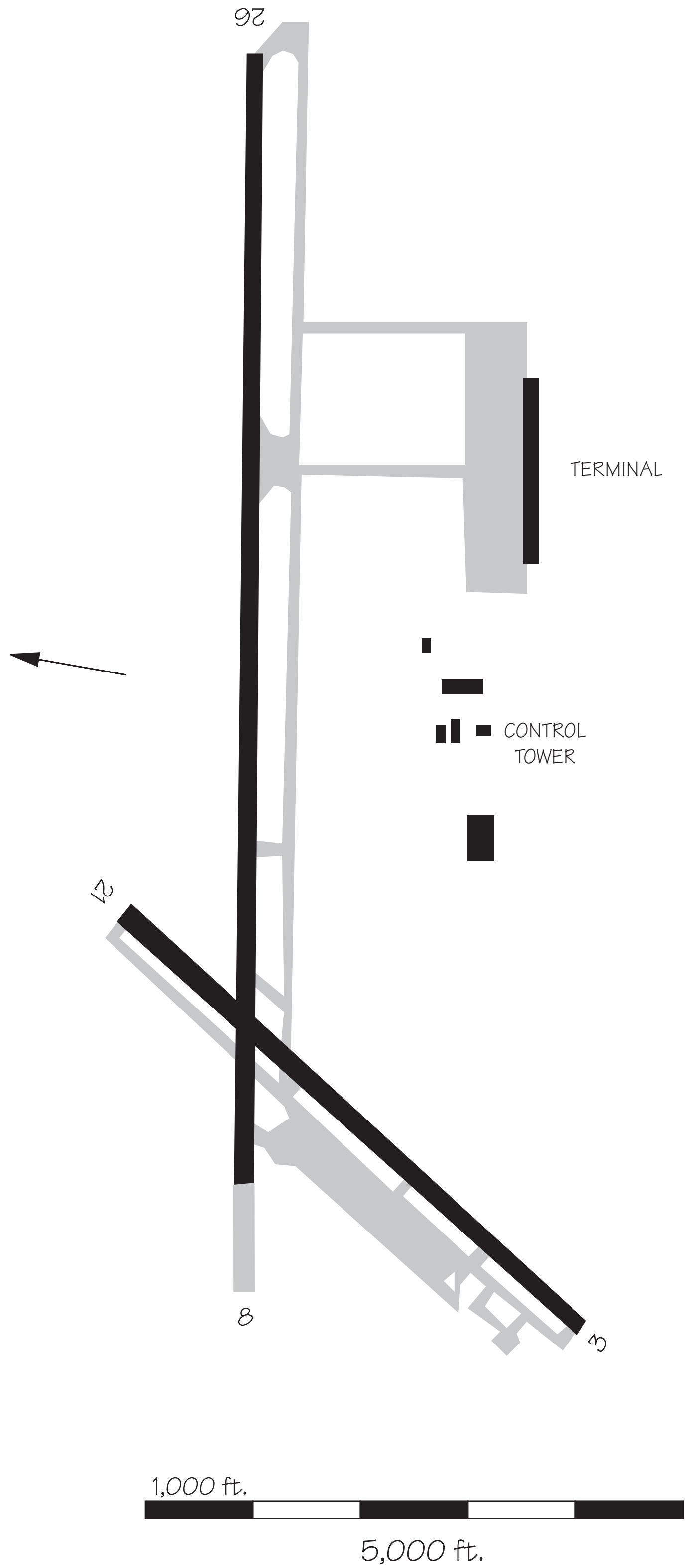
IND — Indianapolis International Airport



ISP — Islip Long Island Mac Arthur Airport

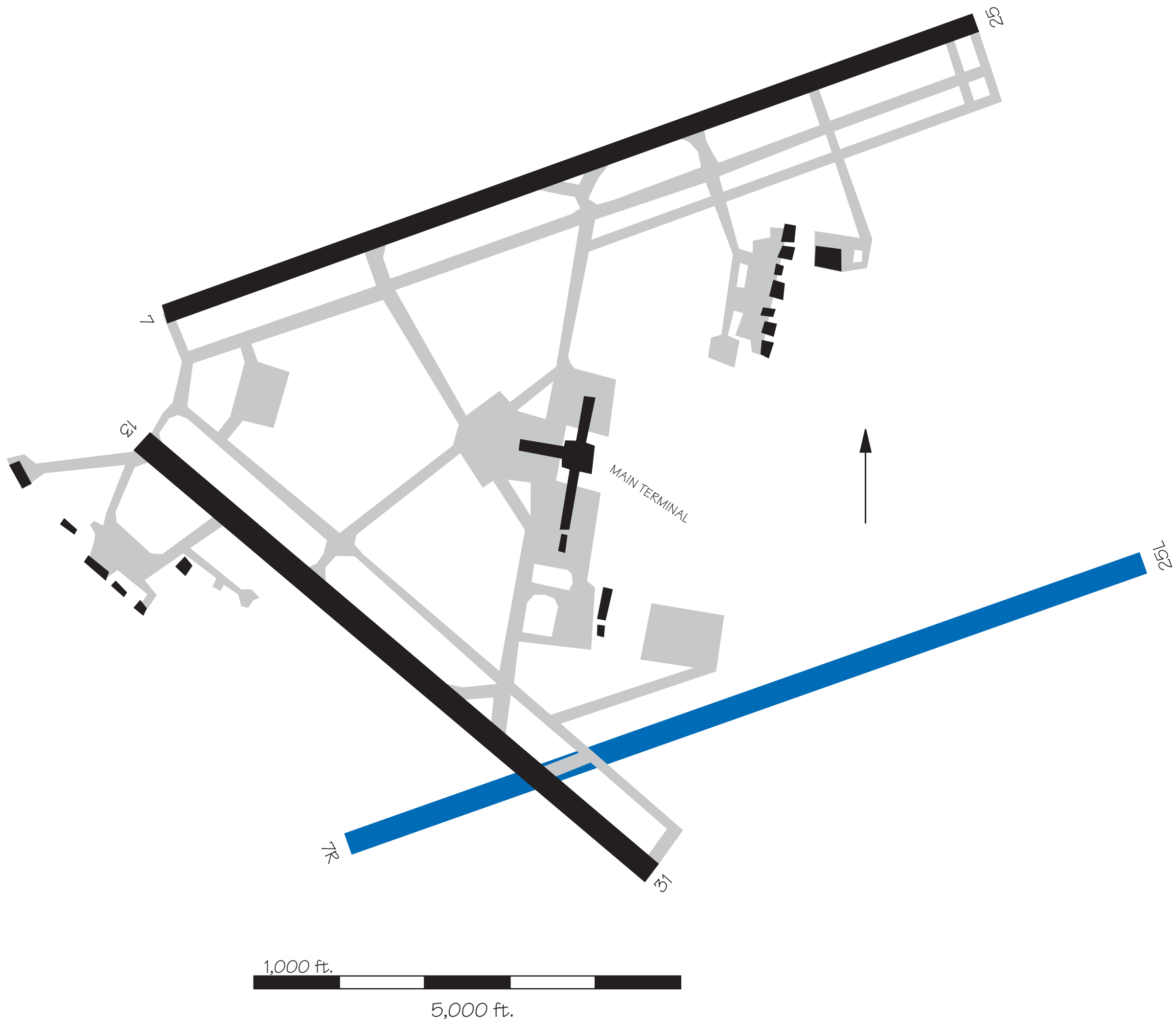


ITO — Hilo International Airport

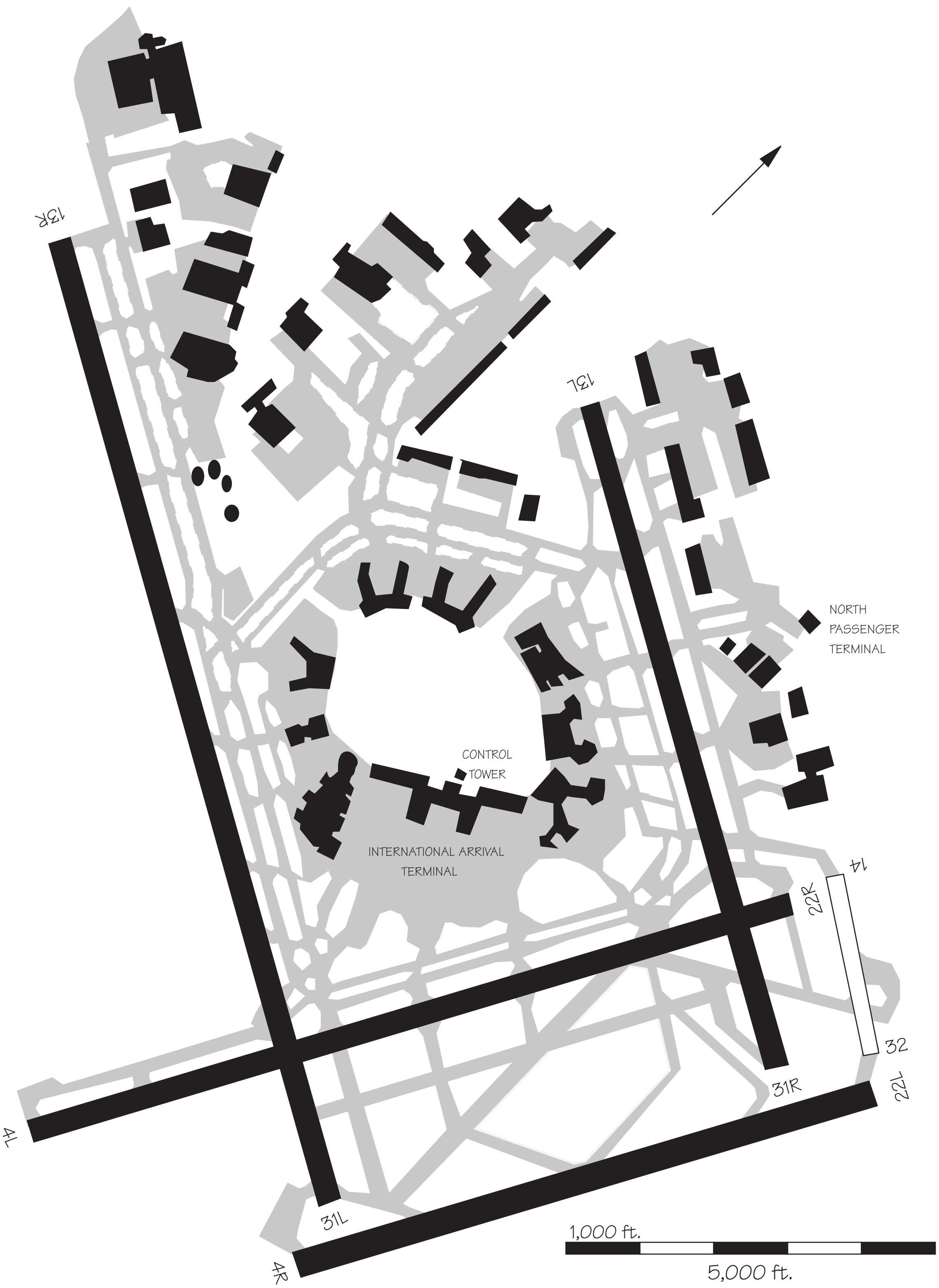


JAX — Jacksonville International Airport

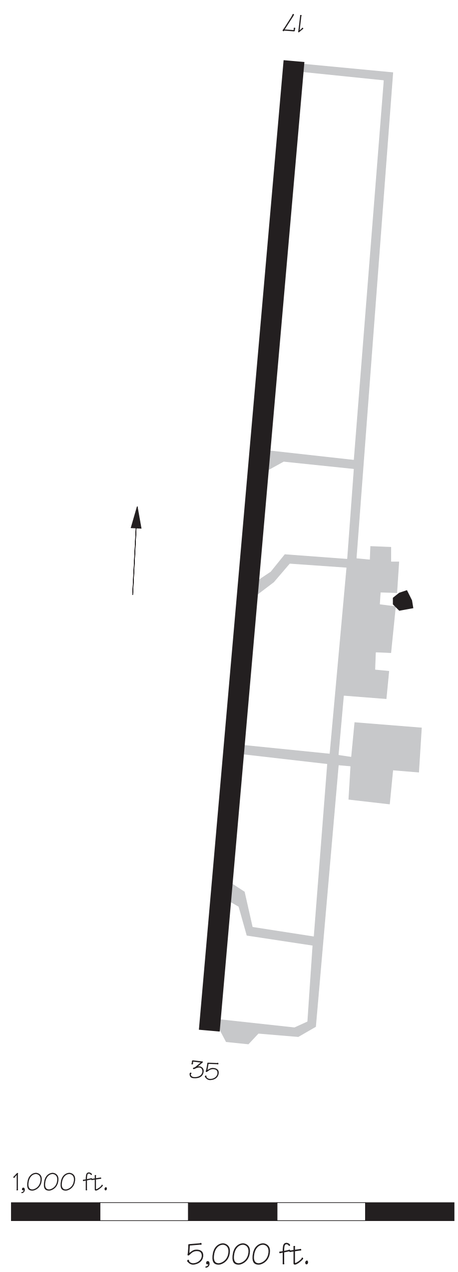
A new parallel Runway 7R/25L is being planned. It will be 6,500 feet south of the existing Runway 7/25, permitting independent parallel IFR operations and potentially doubling Jacksonville's hourly IFR arrival capacity. Construction is scheduled to begin in 2010, with completion expected in 2011. Estimated cost of construction is $50 million.



JFK — New York John F. Kennedy International Airport

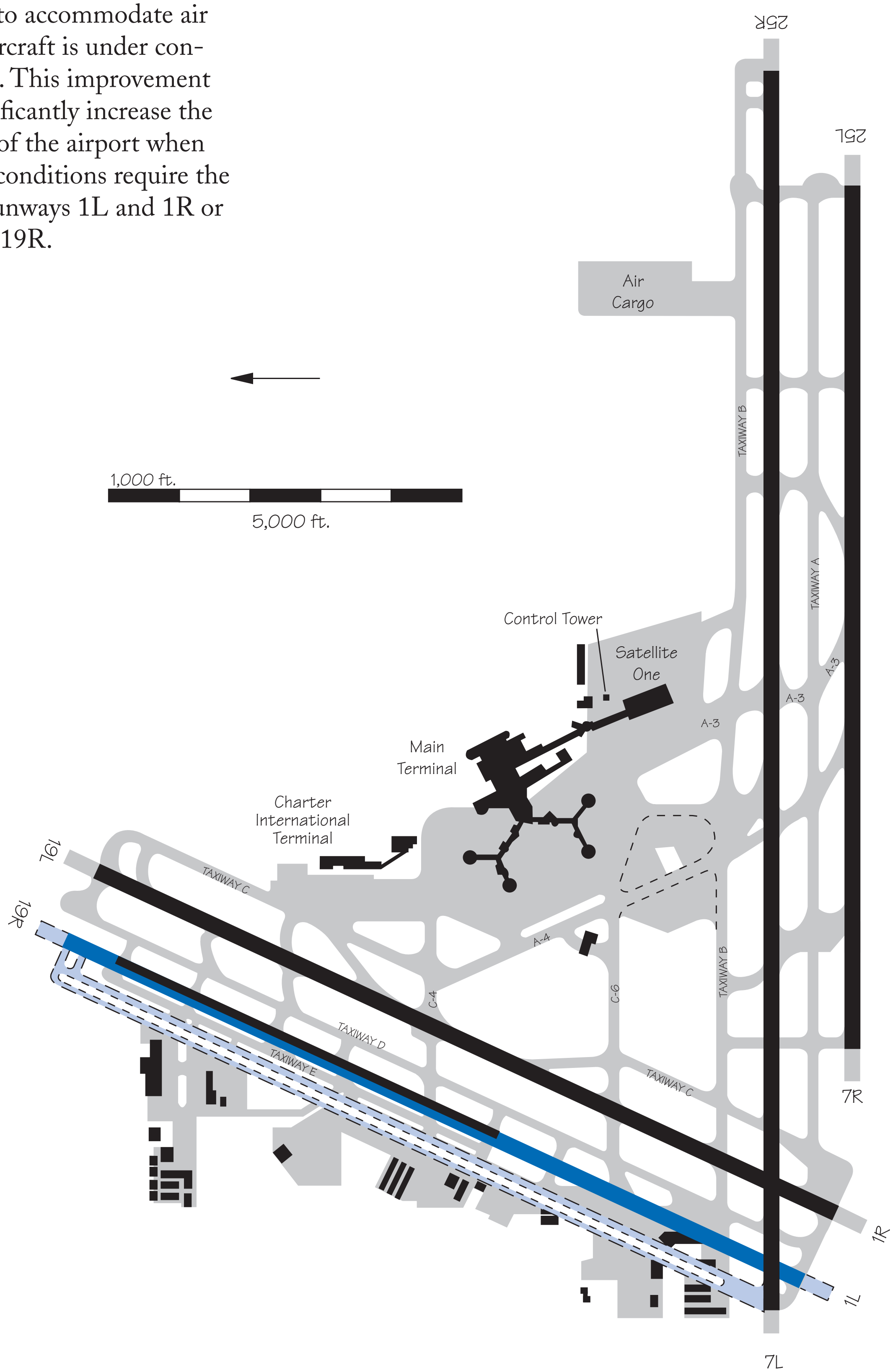


KOA — Kailua-Kona Keahole

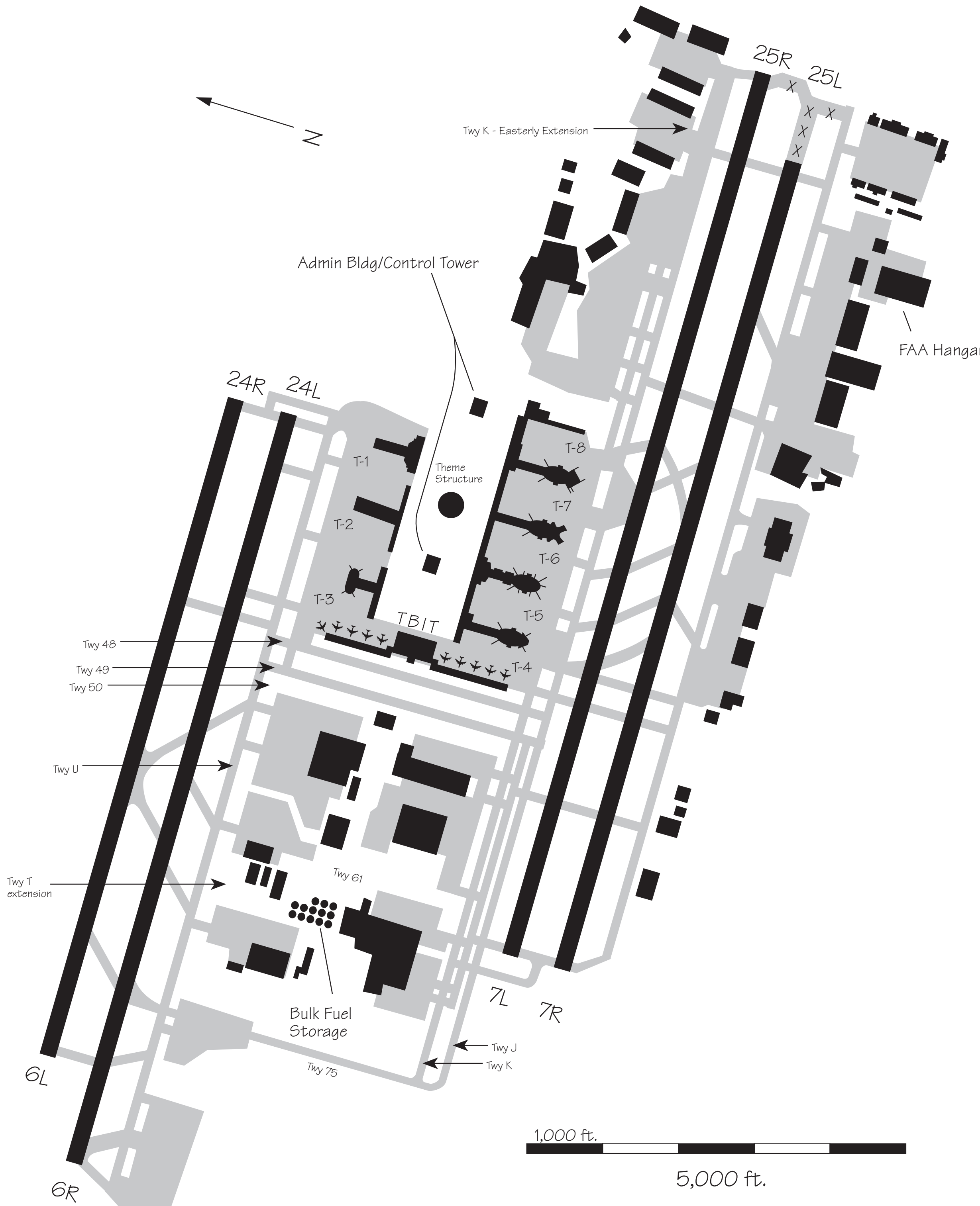


LAS — Las Vegas McCarran International Airport

An upgrade of Runway 1L/19R to accommodate air carrier aircraft is under construction. This improvement will significantly increase the capacity of the airport when weather conditions require the use of Runways 1L and 1R or 19L and 19R.



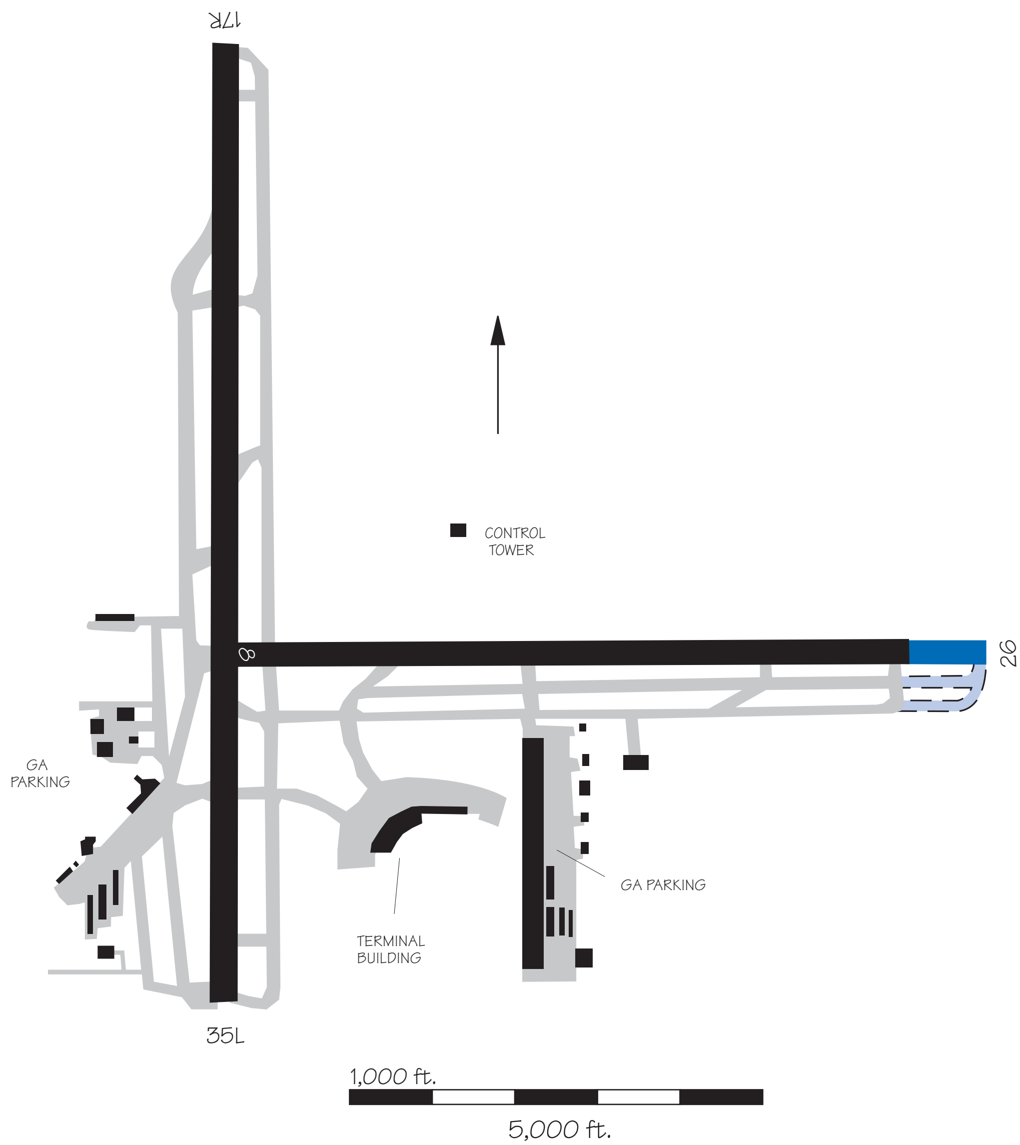
LAX — Los Angeles International Airport



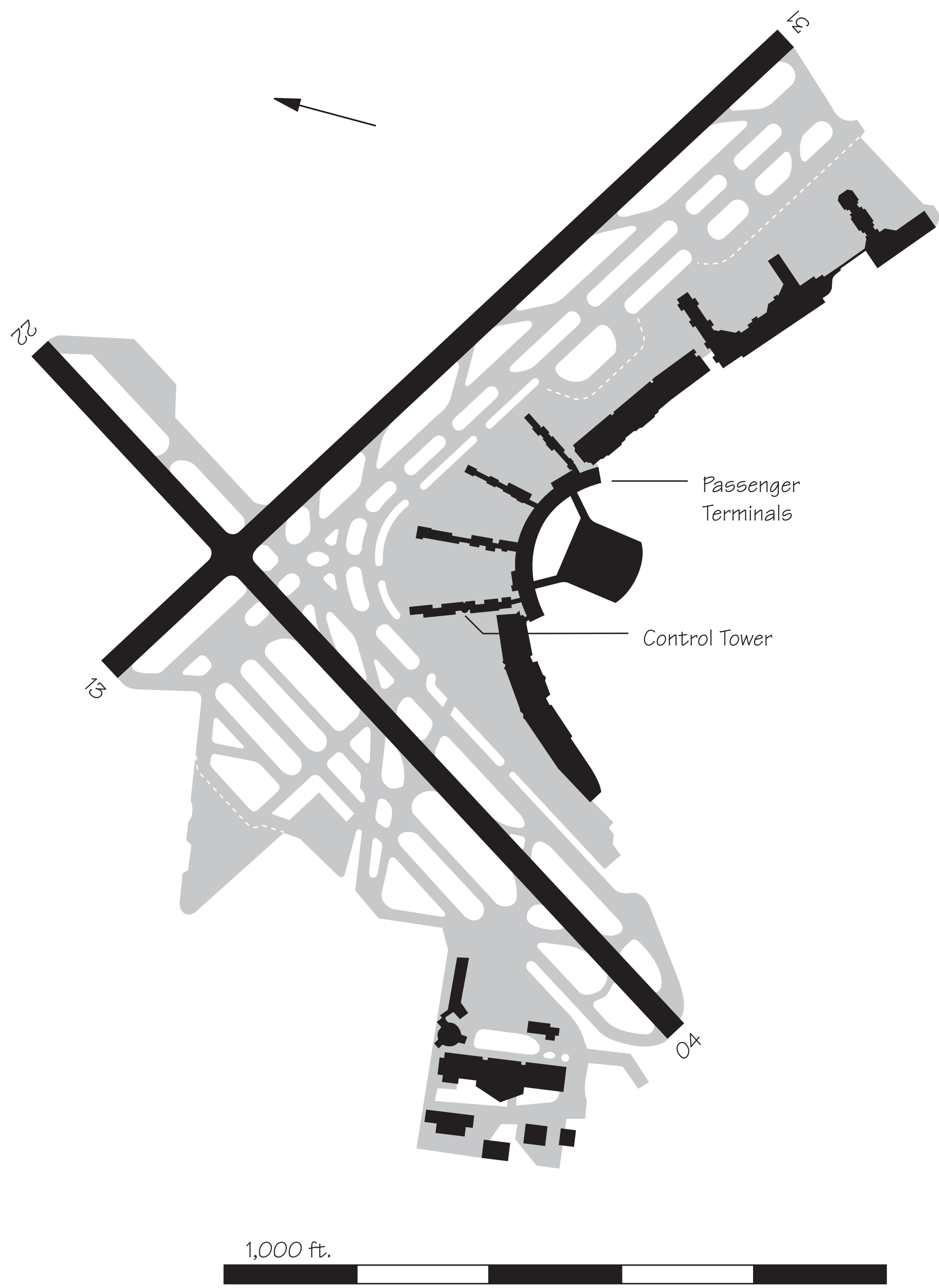
Note: Some buildings/structures have been removed for clarity.

LBB — Lubbock International Airport

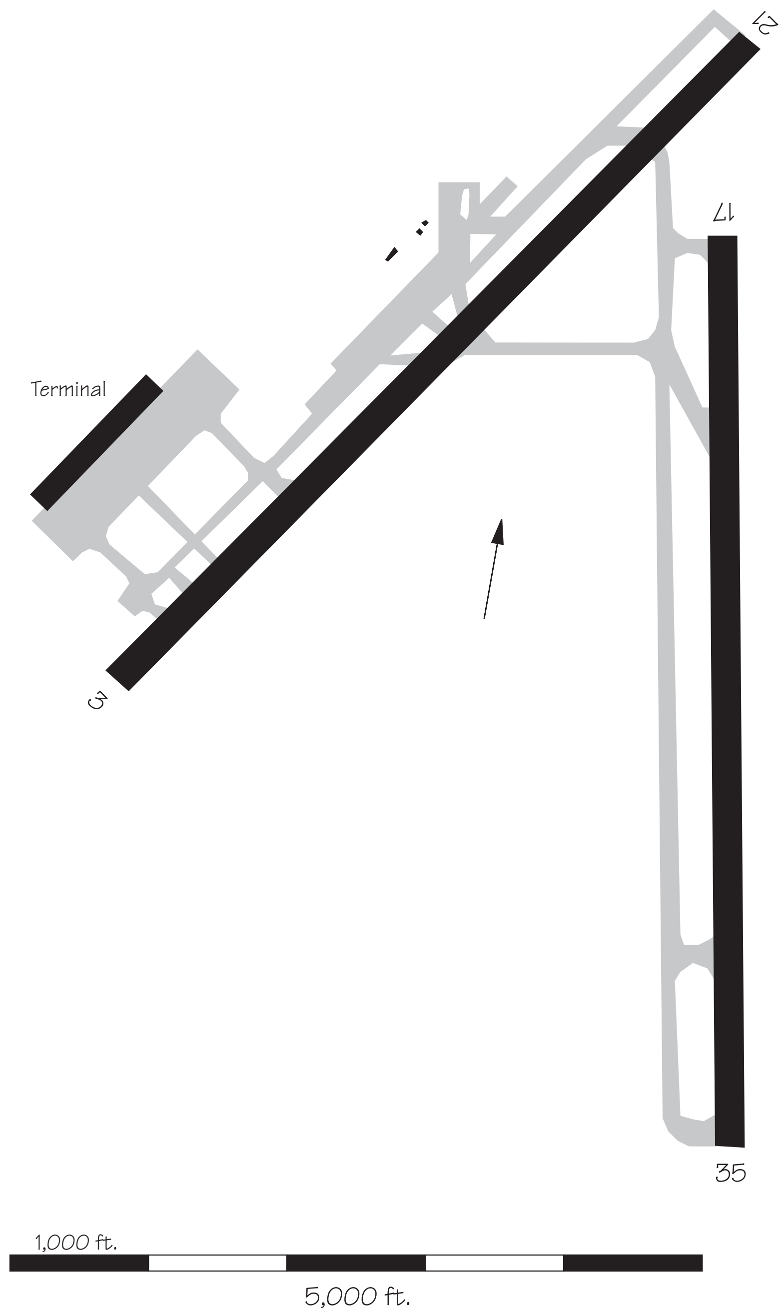
An extension to Runway 8/26 is planned. The start of construction is scheduled for 2004 and the estimated cost is $5 million. It is anticipated that the extension will be operational in 2005.



LGA — New York LaGuardia Airport

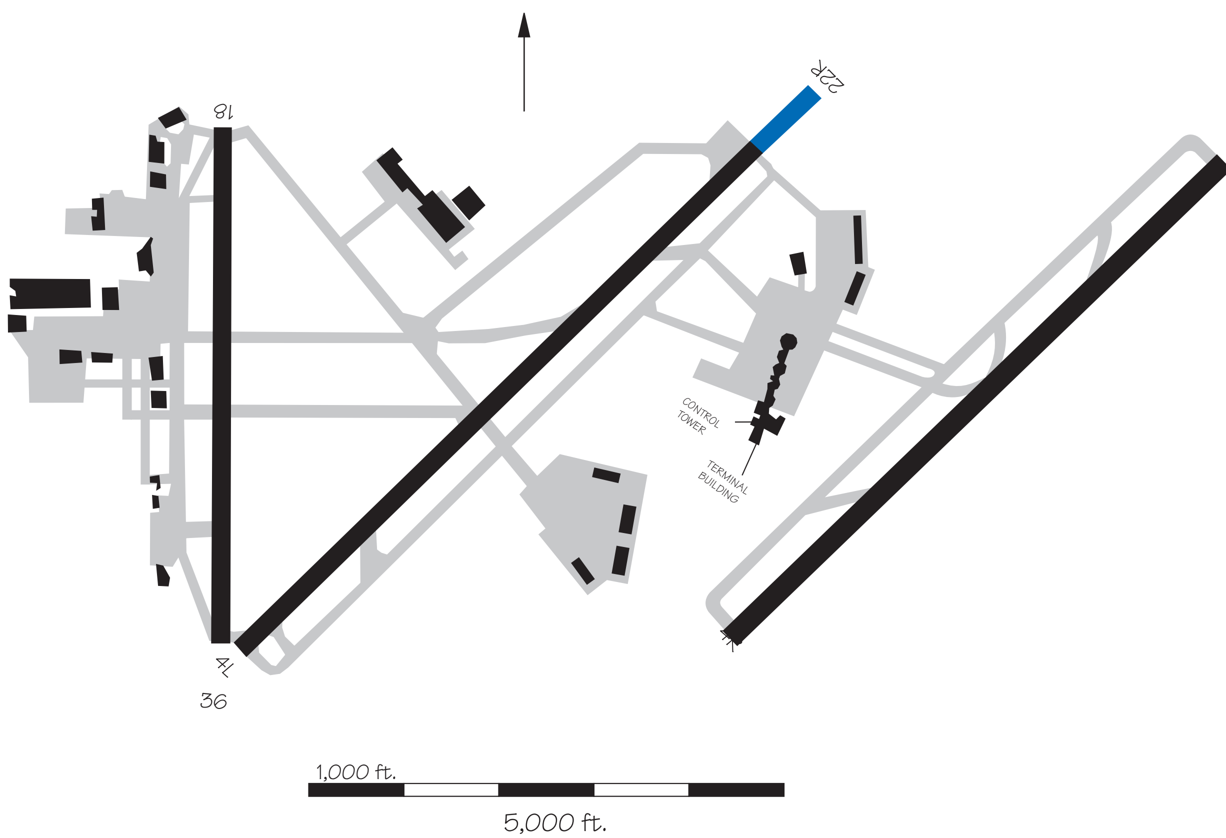


LIH — Lihue Airport



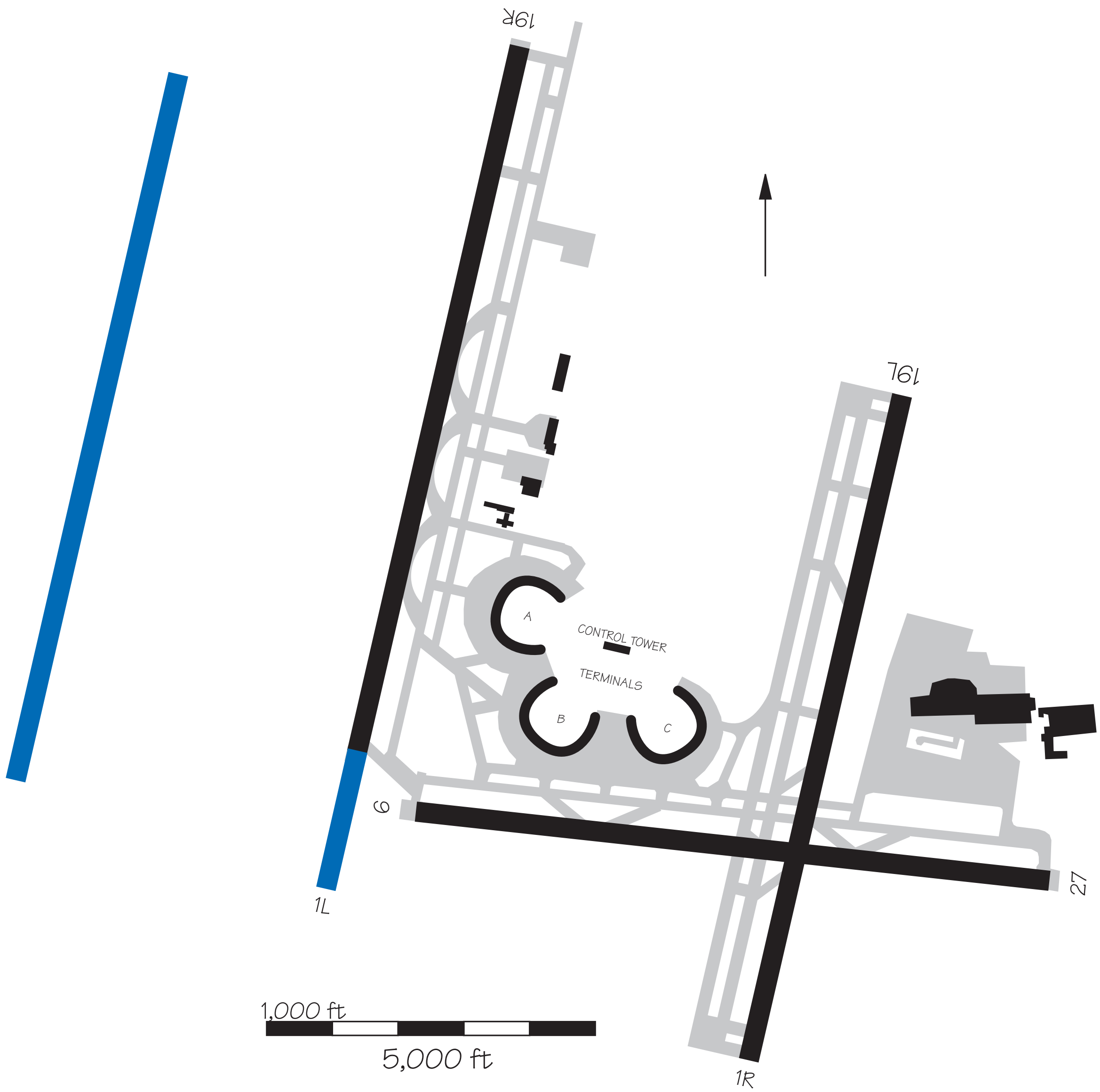
LIT — Little Rock Adams Field

An extension of Runway 4L/22R is underway, and should be operational in early 1998. The estimated cost of construction is $31 million.



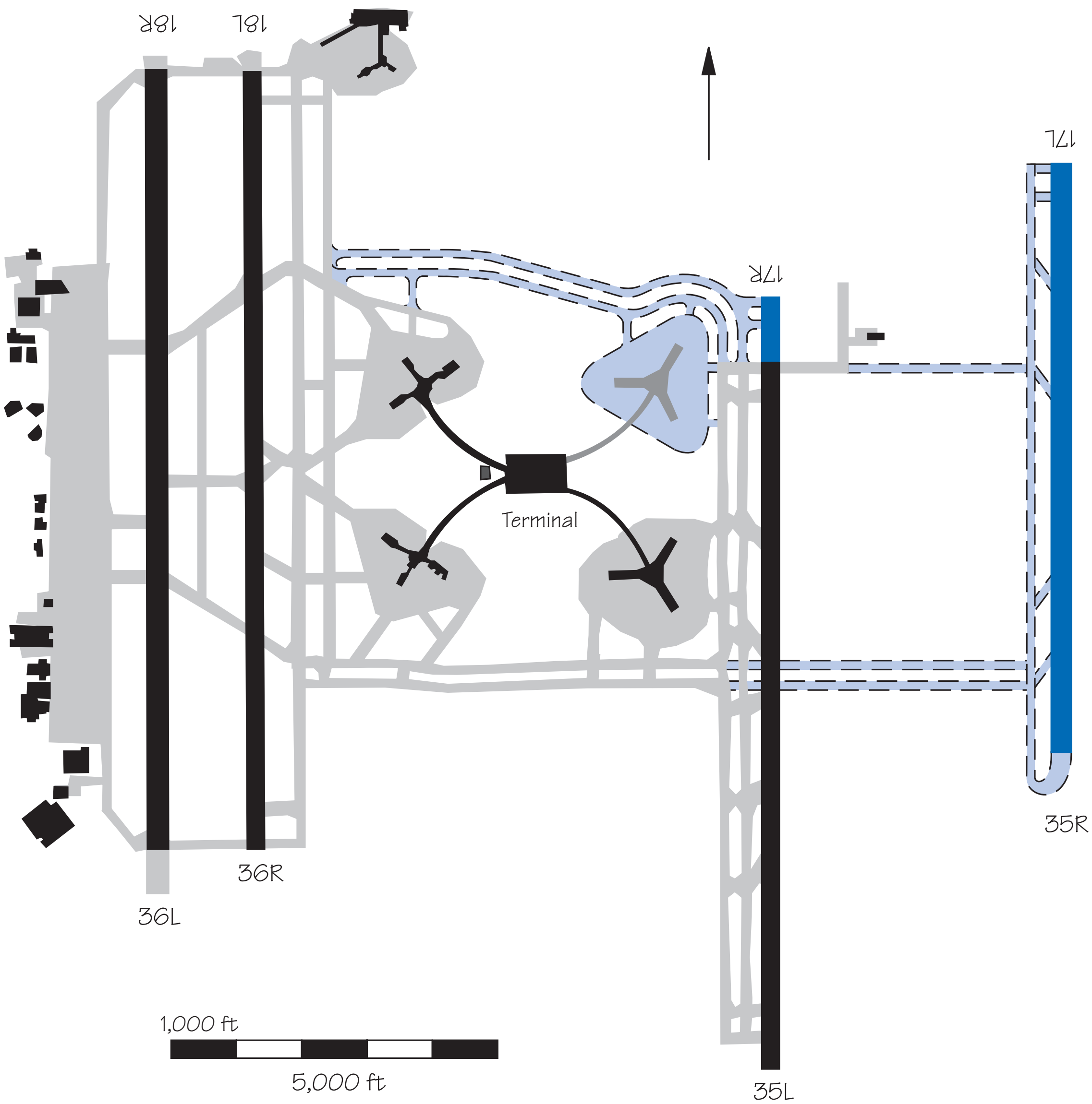
MCI — Kansas City International Airport

In accordance with the Airport Master Plan, an extension of Runway 1L/19R is currently planned. One additional parallel runway west of the existing north-south runway isbeing considered.

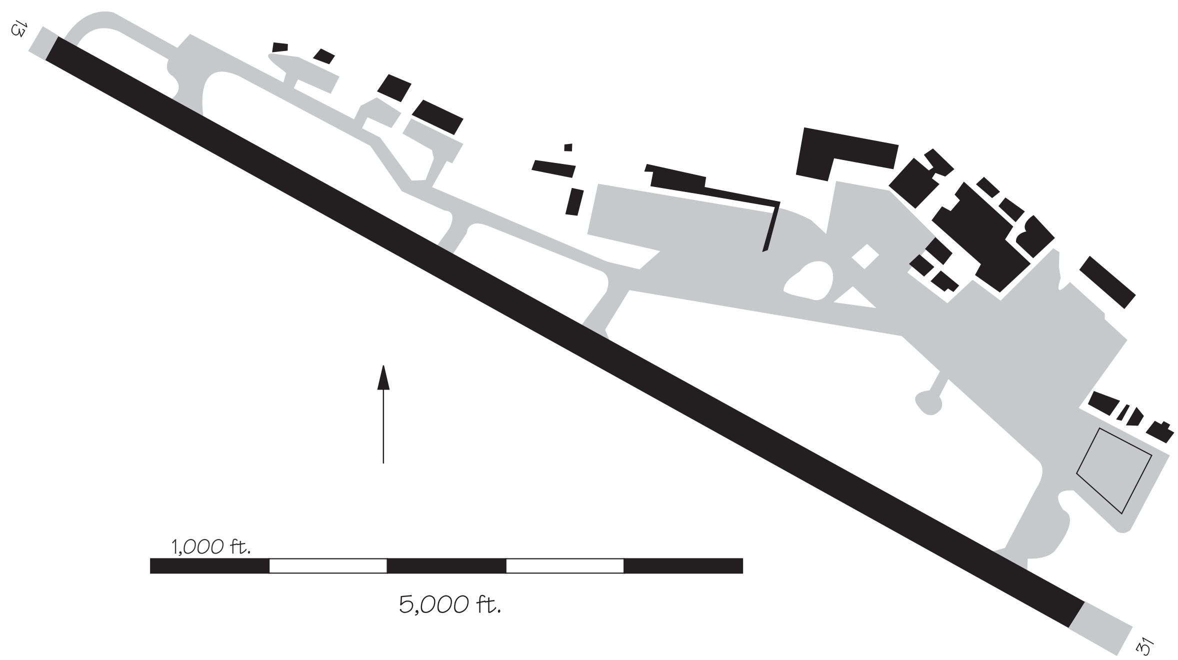


MCO — Orlando International Airport

Environmental mitigation for a fourth north-south runway, Runway 17L/35R, began October 10, 1990 and is ongoing. The runway is expected to be operational in 2002. It will be located 4,300 feet east of Runway 17R/35L. This may permit triple independent IFR operations. The estimated cost of construction of this runway is $137 million. Also planned is a 1,000 ft. extension to Runway 17R/35L.

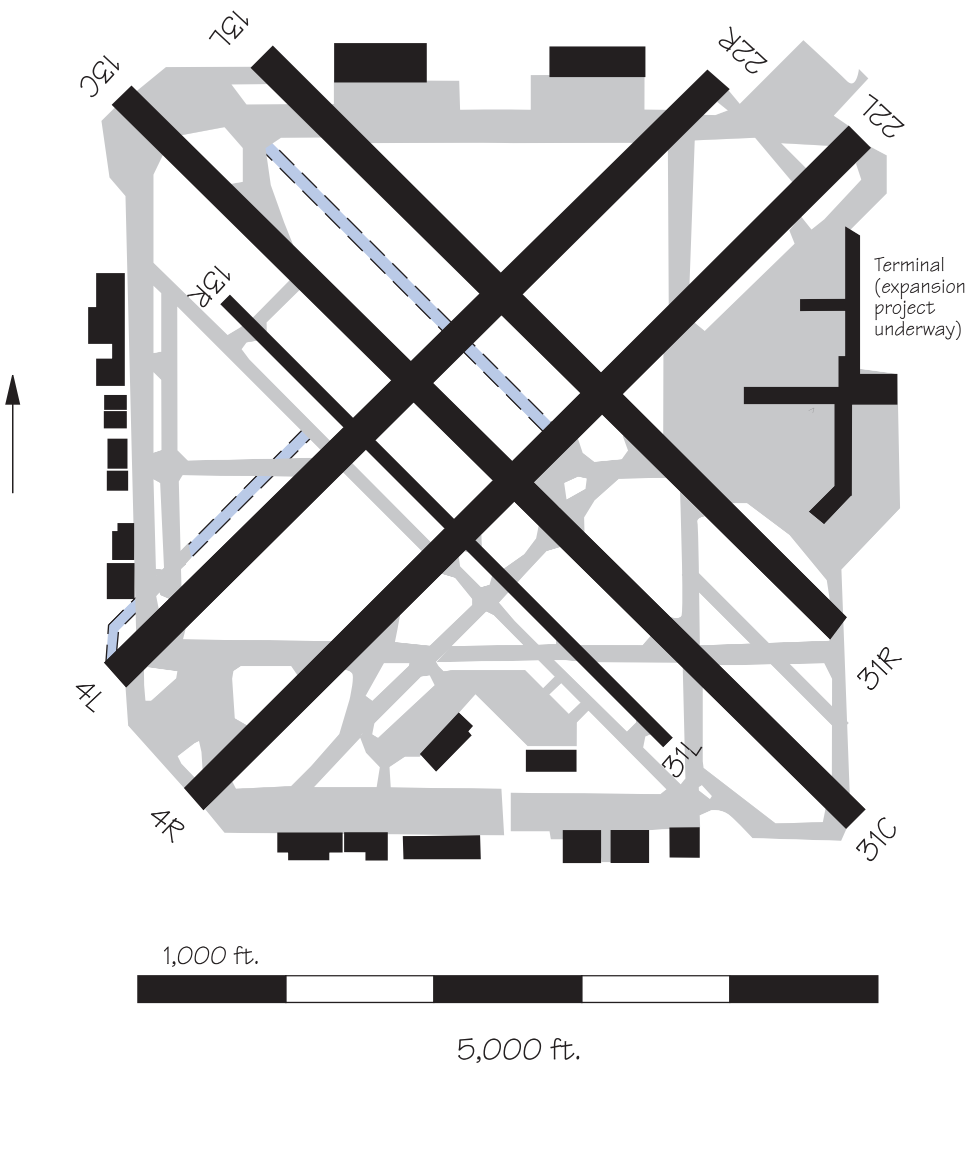


MDT — Harrisburg International Airport



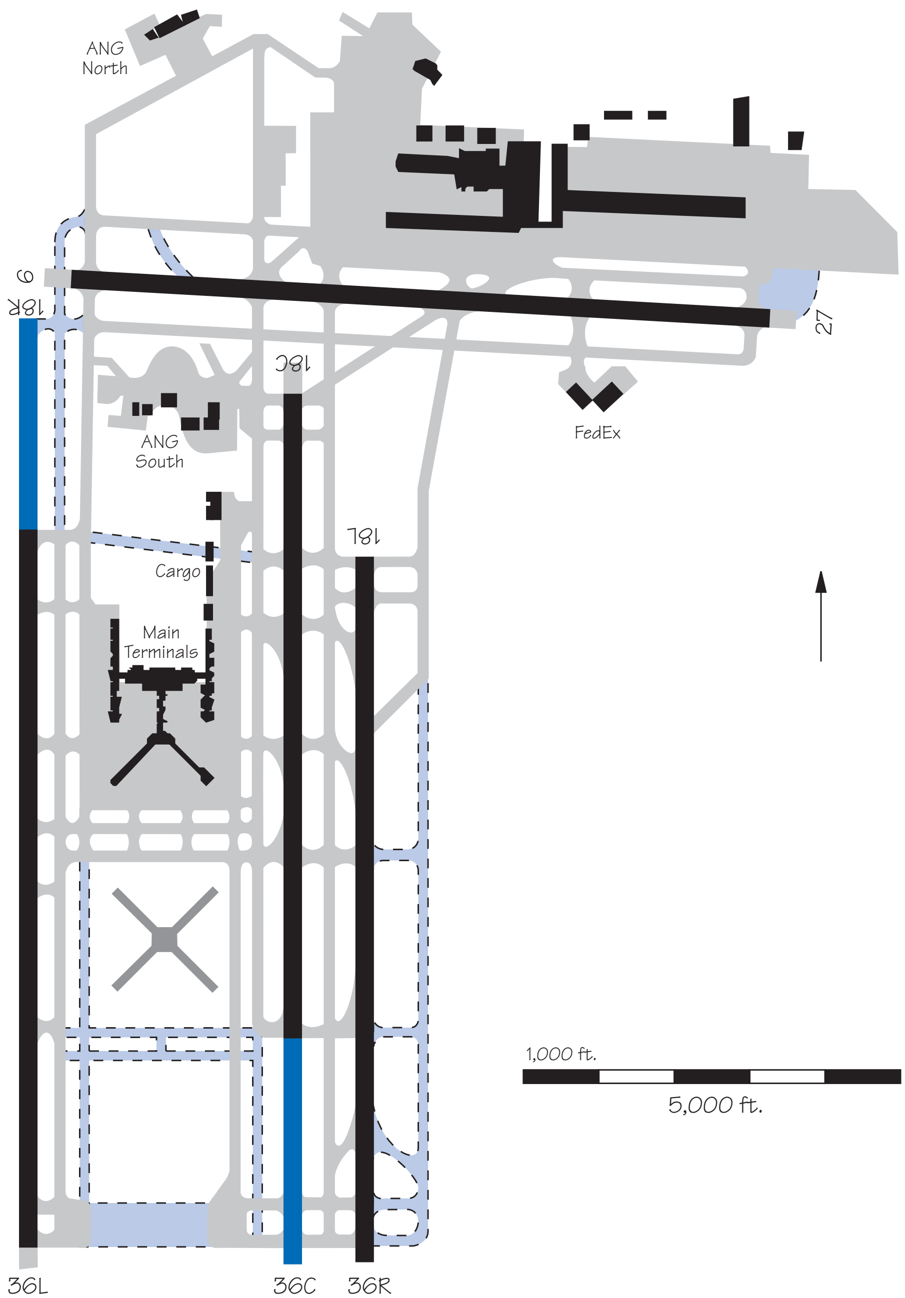
MDW — Chicago Midway Airport

Reconstruction of Runway 4R/22L is scheduled to start in 1997, with a projected cost of $32 million. The project is expected to be completed that same year.



MEM — Memphis International Airport

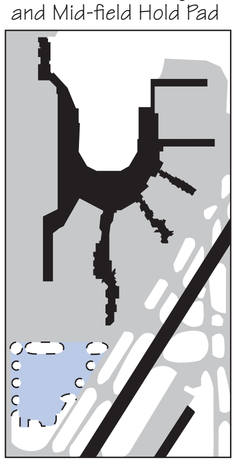
A new north-south parallel Runway 18L/36R opened in mid 1997. It is located 927 feet east of Runway 18C/36C (old 18L/36R) and 4,327 feet from Runway 18R/36L, thus allowing independent parallel approaches. This increased hourly IFR arrival capacity by about 33 percent. A reconstruction and extension of Runway 18C/36C is under way. Construction is expected to be completed by 2000 at a cost of $103 million.



MIA — Miami International Airport

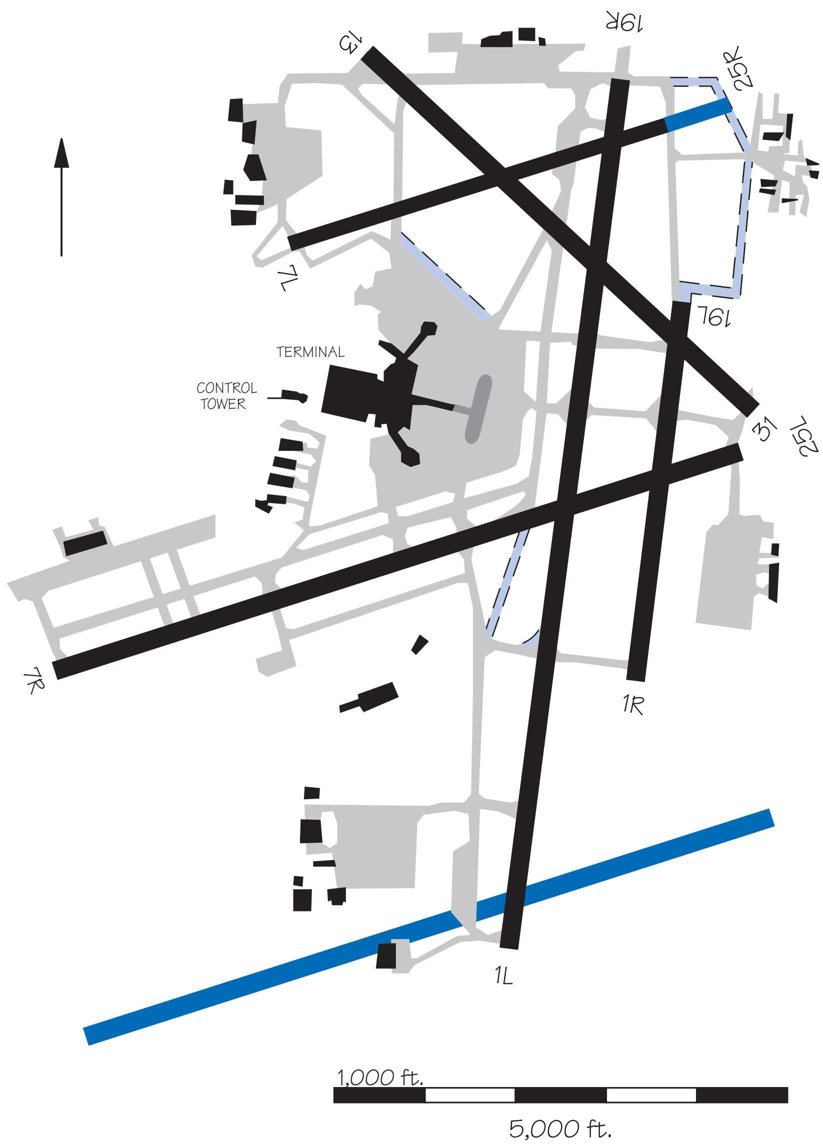
Construction of a new air carrier runway, 8,600 feet long and 800 feet north of existing Runway 9L/27R, is expected to start in 1999 and be completed by 2002. The estimated cost of construction is $180 million. An EIS is expected to be completed in late 1998.

New Terminal Design
and Mid-field Hold Pad



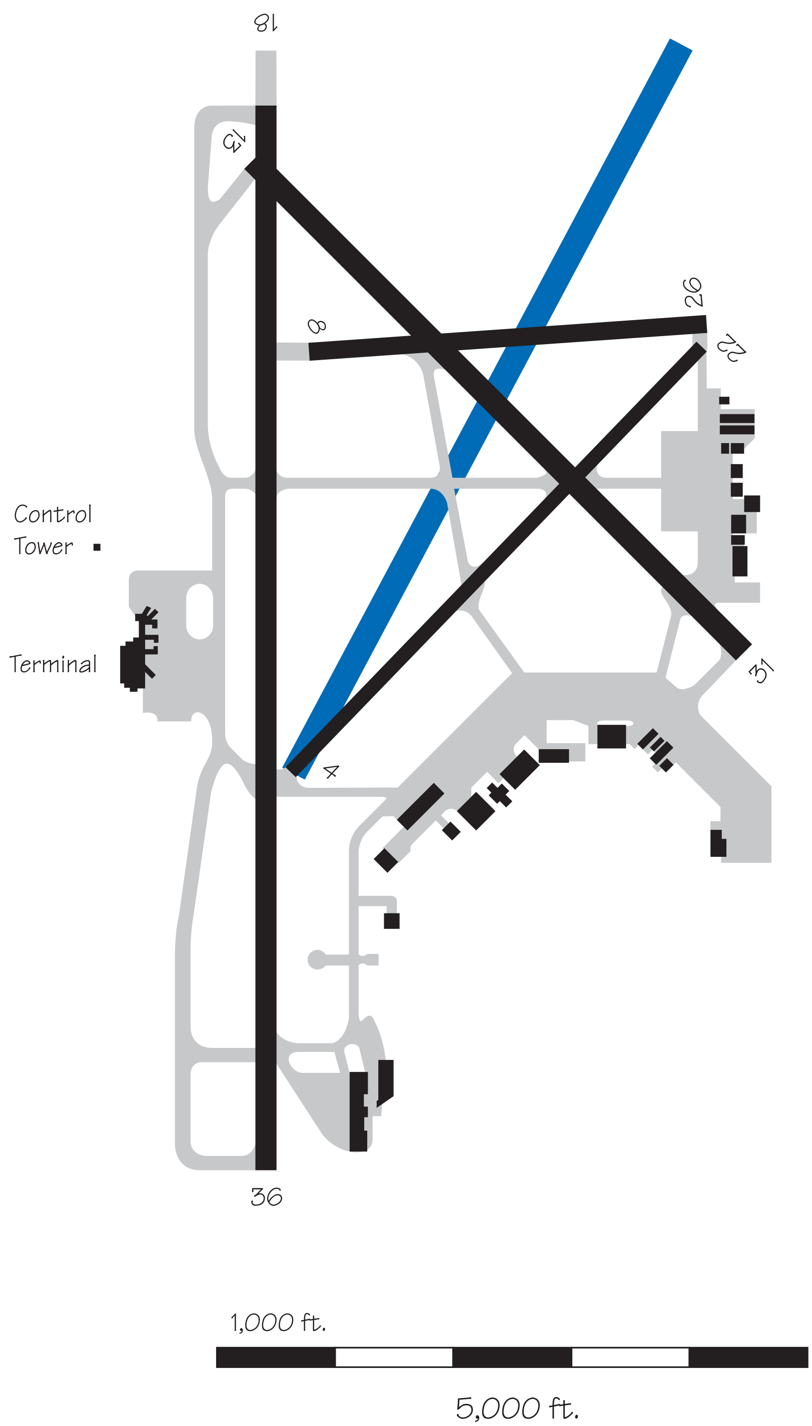
MKE — Milwaukee General Mitchell International Airport

A planned 700 feet extension to Runway 7L/25R is undergoing environmental review. Extension of this runway form 4,100 feet to 4,800 feet will accommodate commuter aircraft and delay the need for a third parallel runway until about the year 2015. Anticipated cost of the runway extension is approximately $1.9 million, with construction scheduled to begin in 1998.



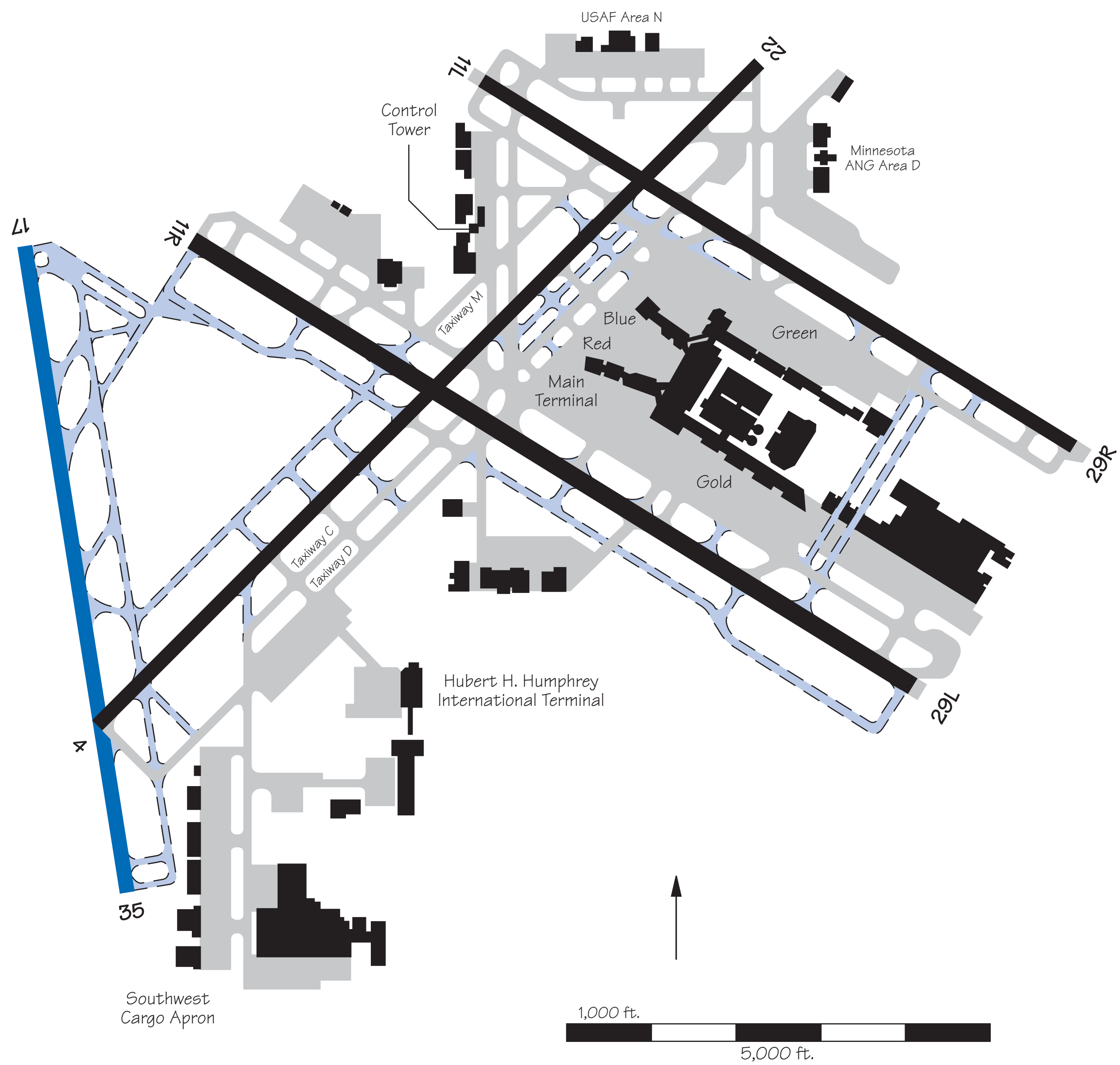
MSN — Dane County Regional Airport

A new runway (3/21), is proposed to be built to provide additional operational capabilities to direct flights away from noise sensitive areas. This will be necessary when Runway 18/36 reaches its limit to run operations in reverse flow for noise abatement purposes during peak operating hours. Runway 3/21 would replace Runway 4/22. It is not feasible to extend 4/22 to have the same operational capabilities desired of Runway 3/21. The estimated cost of construction is $15 million. An EIS is underway.



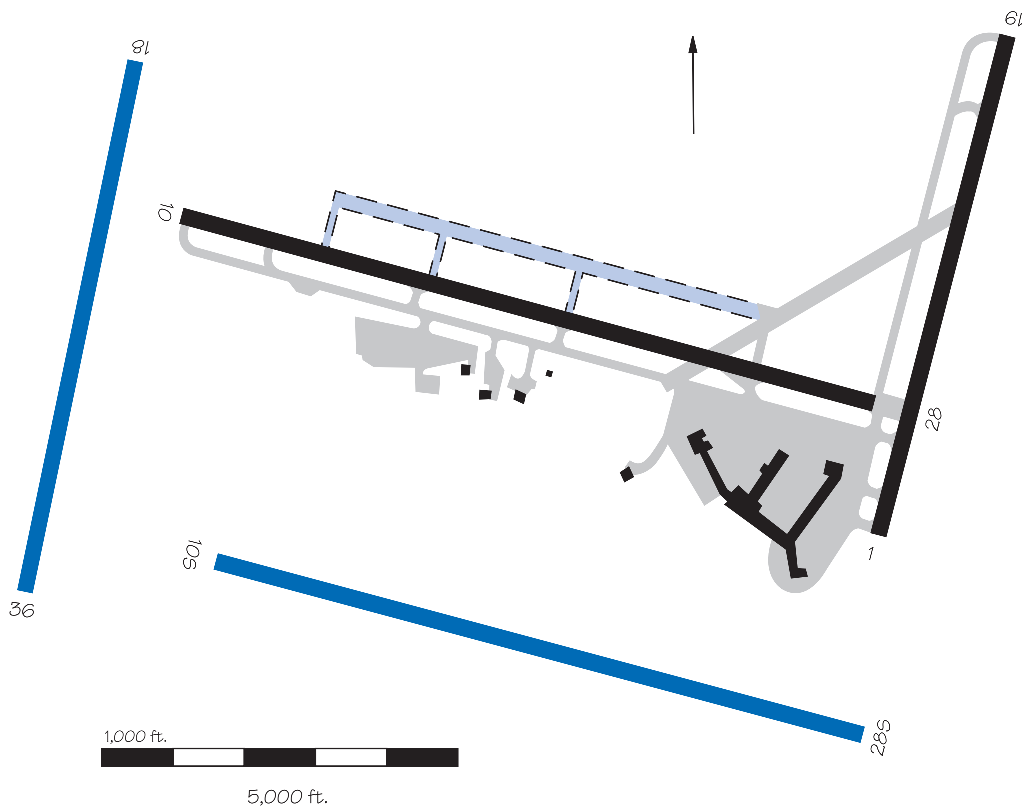
MSP — Minneapolis-St. Paul International Airport

Construction of the proposed 8,000 feet Runway 17/35, at a cost of $175 million, will reduce the projected 2020 annual delay cost from $66 million to $38 million. The runway is expected to be operational in 2003 and will be used primarily for departures to the south and arrivals to the north.



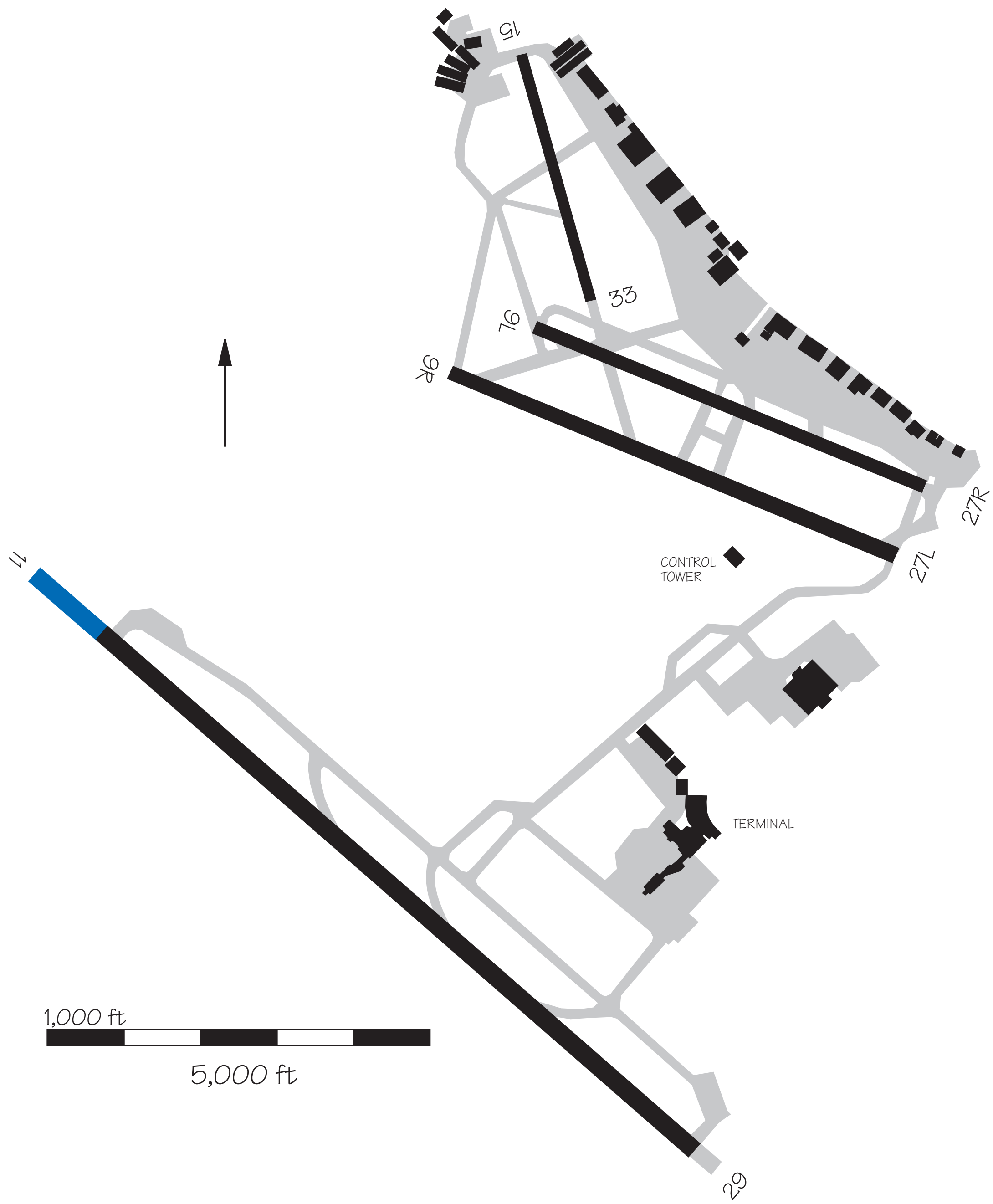
MSY — New Orleans International Airport

A new north-south runway, Runway 18/36, is planned. This new runway will be near parallel to the existing Runway 1/19 and will be located west of the threshold of Runway 10, approximately 11,000 feet away from Runway 1/19. This will allow independent parallel operations, doubling IFR hourly arrival capacity. Pending environmental approvals, construction could begin as early as 2000 and be completed in 2005, at an approximate cost of $400 million. As an alternative to this north-south runway, the airport is considering the construction of an east/west parallel runway, Runway 10S/28S, 4,300 feet to the south of existing Runway 10/28, off of present airport property. The airport is also constructing a north parallel east/west taxiway approximately 800 feet north of and parallel to the existing Runway 10/28, which could later be converted into a 6,000-foot commuter and general aviation runway. The estimated cost of construction is $34 million, and the expected operational date is late 1999.



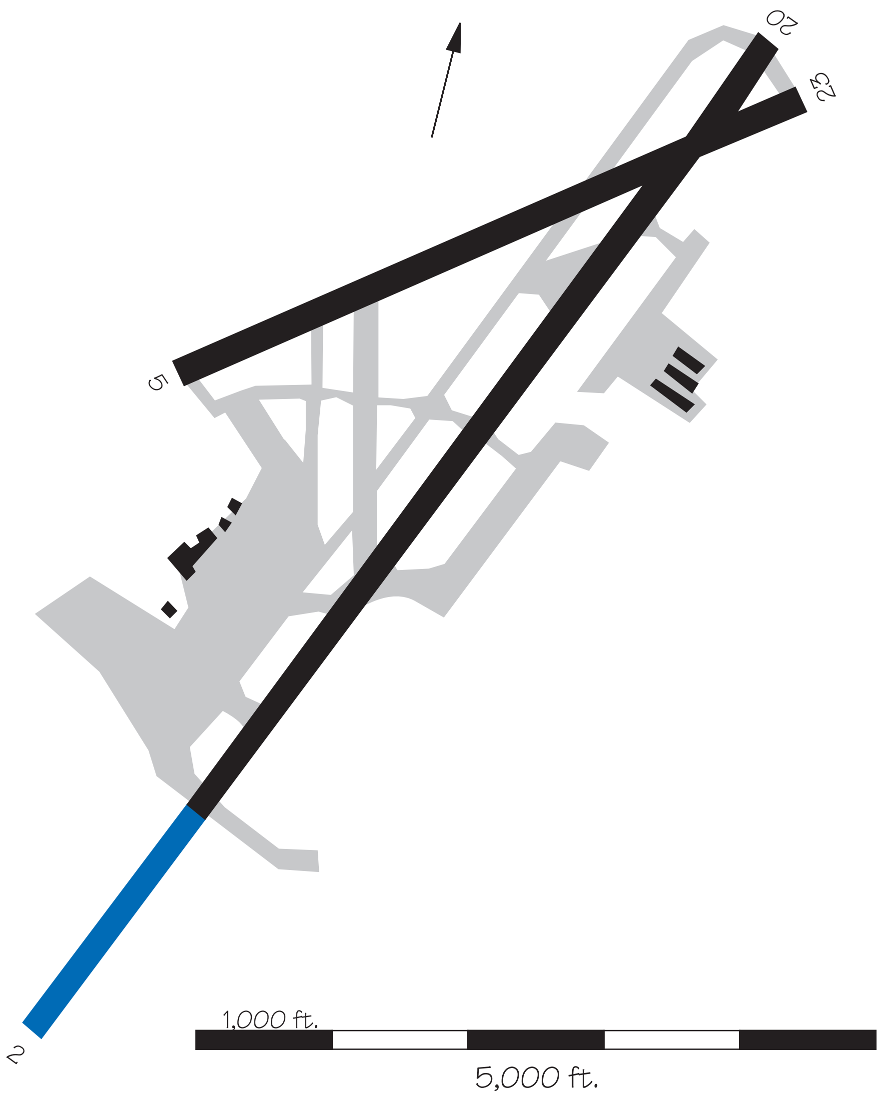
OAK — Metropolitan Oakland International Airport

An extension to Runway 11/29 is planned for ultimate development.



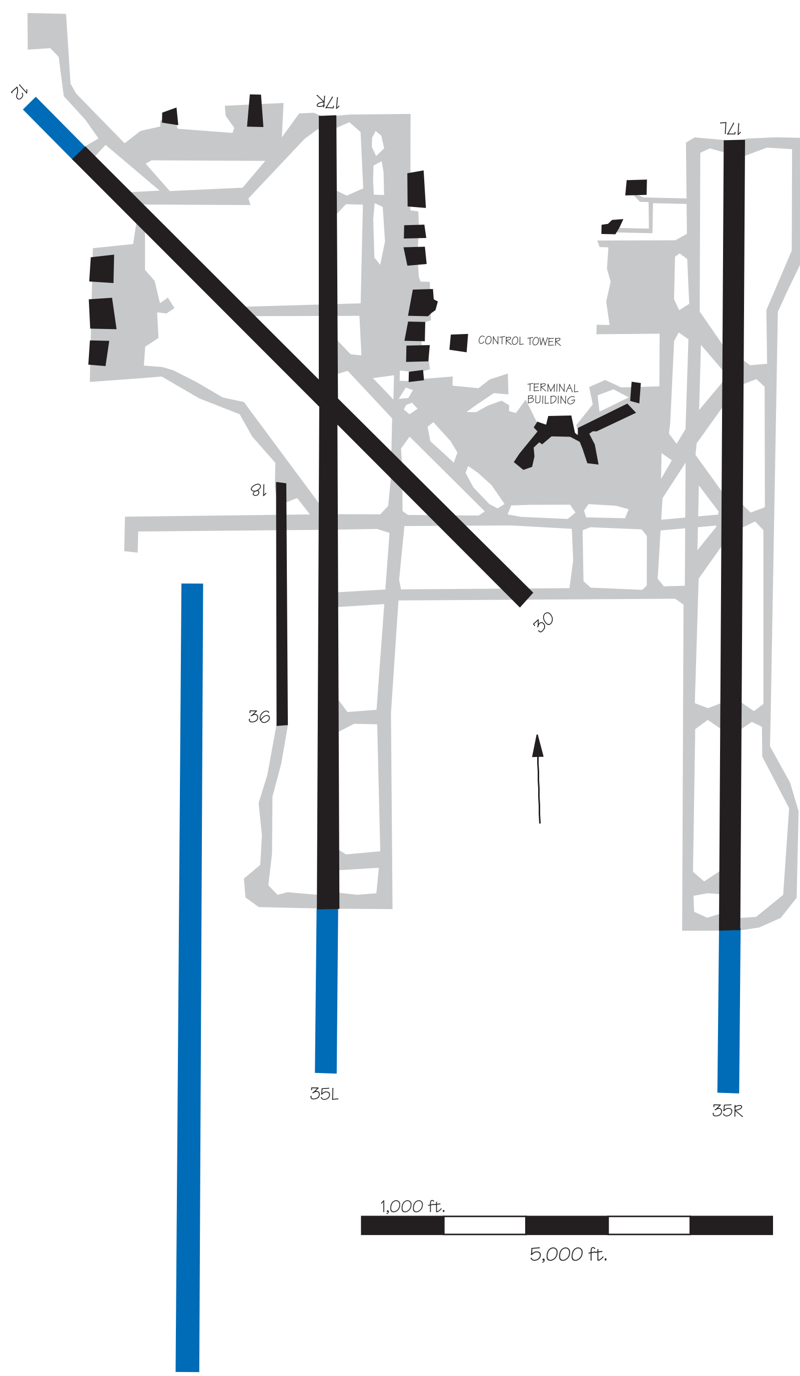
OGG — Kahului Airport

An extension of Runway 2/20 is being planned. An EIS is underway, and the extension could be operational by mid-1998, at a cost of $40 million.



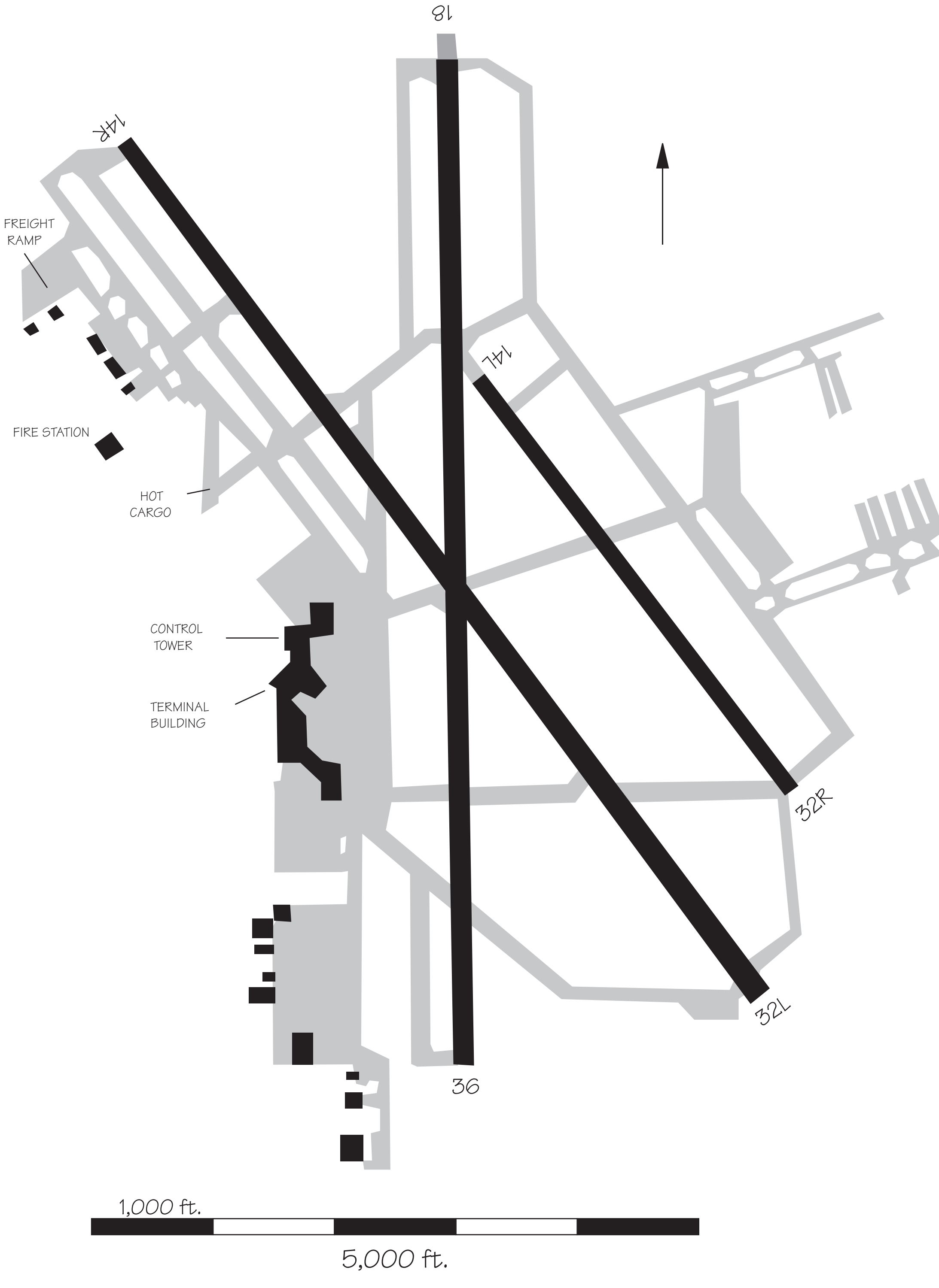
OKC — Oklahoma City Will Rogers World Airport

Construction of a new west parallel runway 1,600 feet west of Runway 17R/35L is planned to be operational by 2004. Estimated cost of construction is $13 million. Extensions to both north/south runways, Runways 17L/35R and 17R/35L, are also planned. The estimated cost of extending the runways is $8 million each. Construction of the extension to Runway 17R/35L is expected to start in 2001 and be completed by 2014. A 1,200 foot extension to the northwest of Runway 13/31 is planned as well. Construction is stated to begin in 2003, be completed in 2005, and cost $5 million.

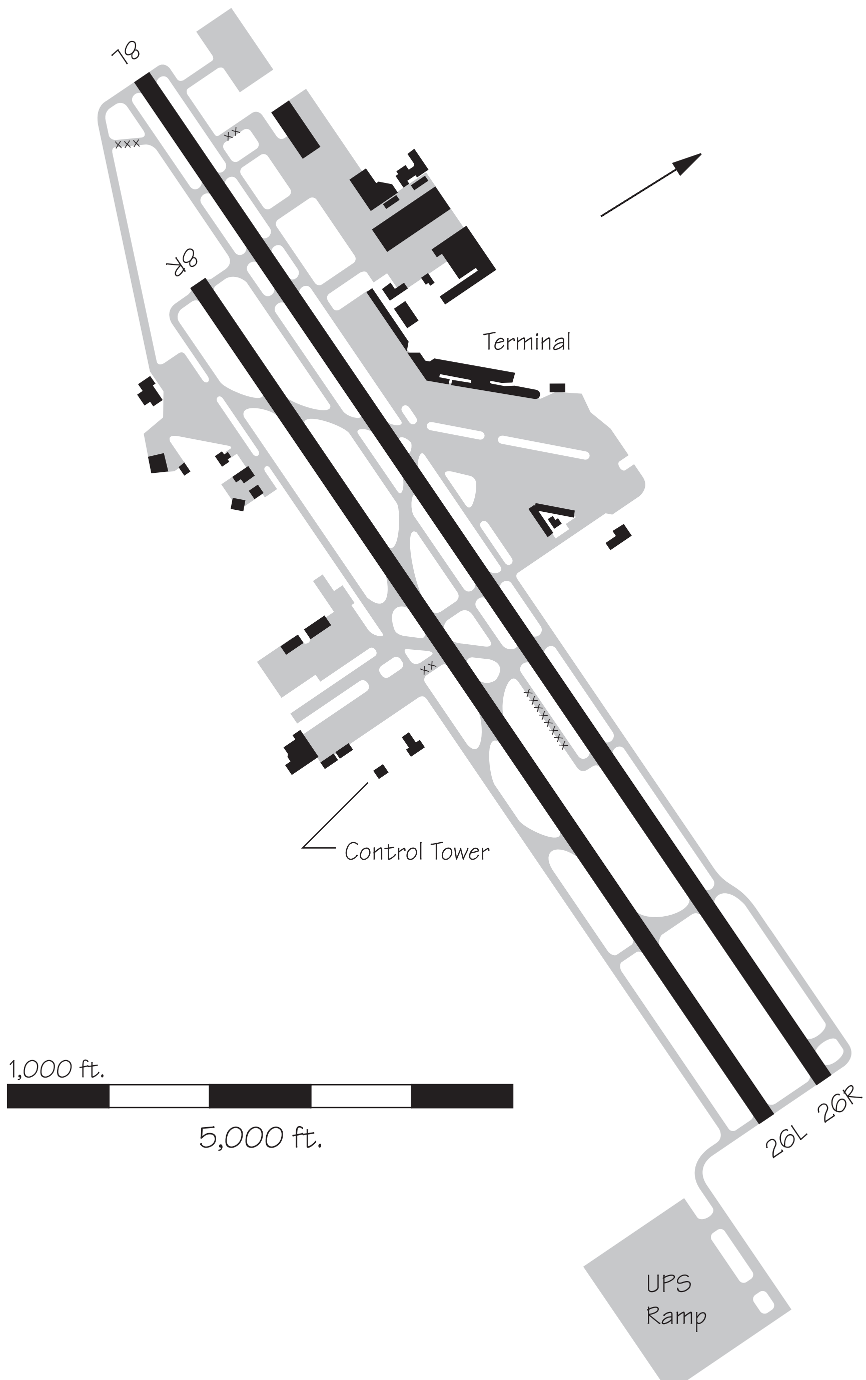


OMA — Omaha Eppley Airfield

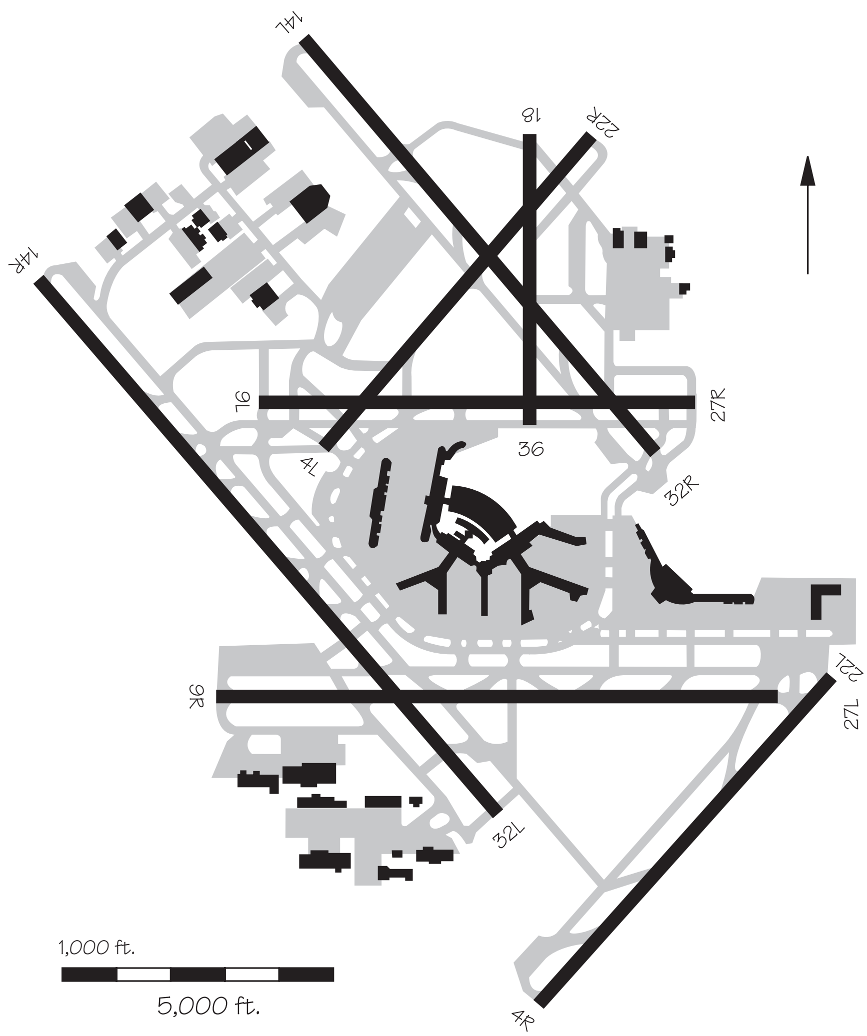
An extension to Runway 14R/32L was completed (1,000 feet) in 1996.



ONT — Ontario International Airport

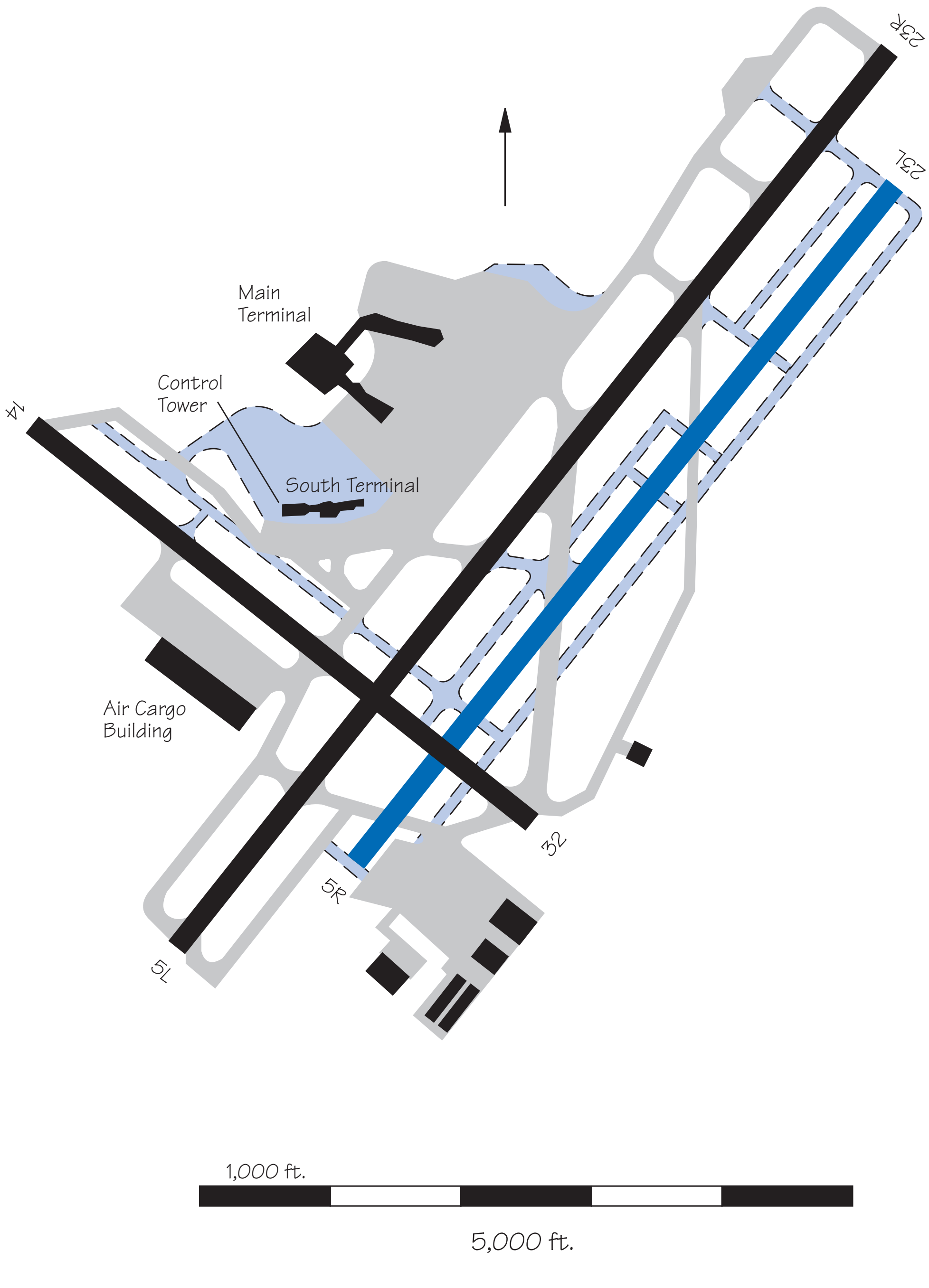


ORD — Chicago O'Hare International Airport



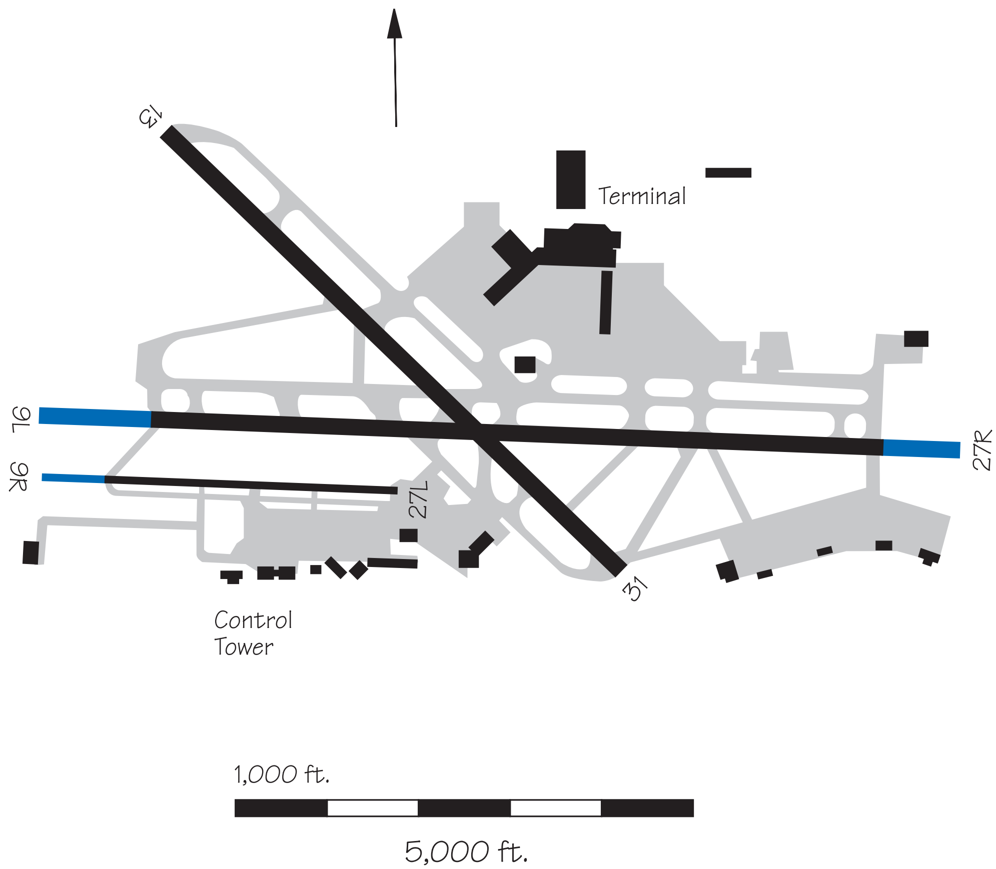
ORF — Norfolk International Airport

A new air carrier runway, Runway 5R/23L, was analyzed by the Eastern Virginia Capacity Design Team. A Master Plan Update is currently underway. The runway could be operational by 2005, at an estimated cost of $75 million, providing the airport can acquire the small amount of additional land required.

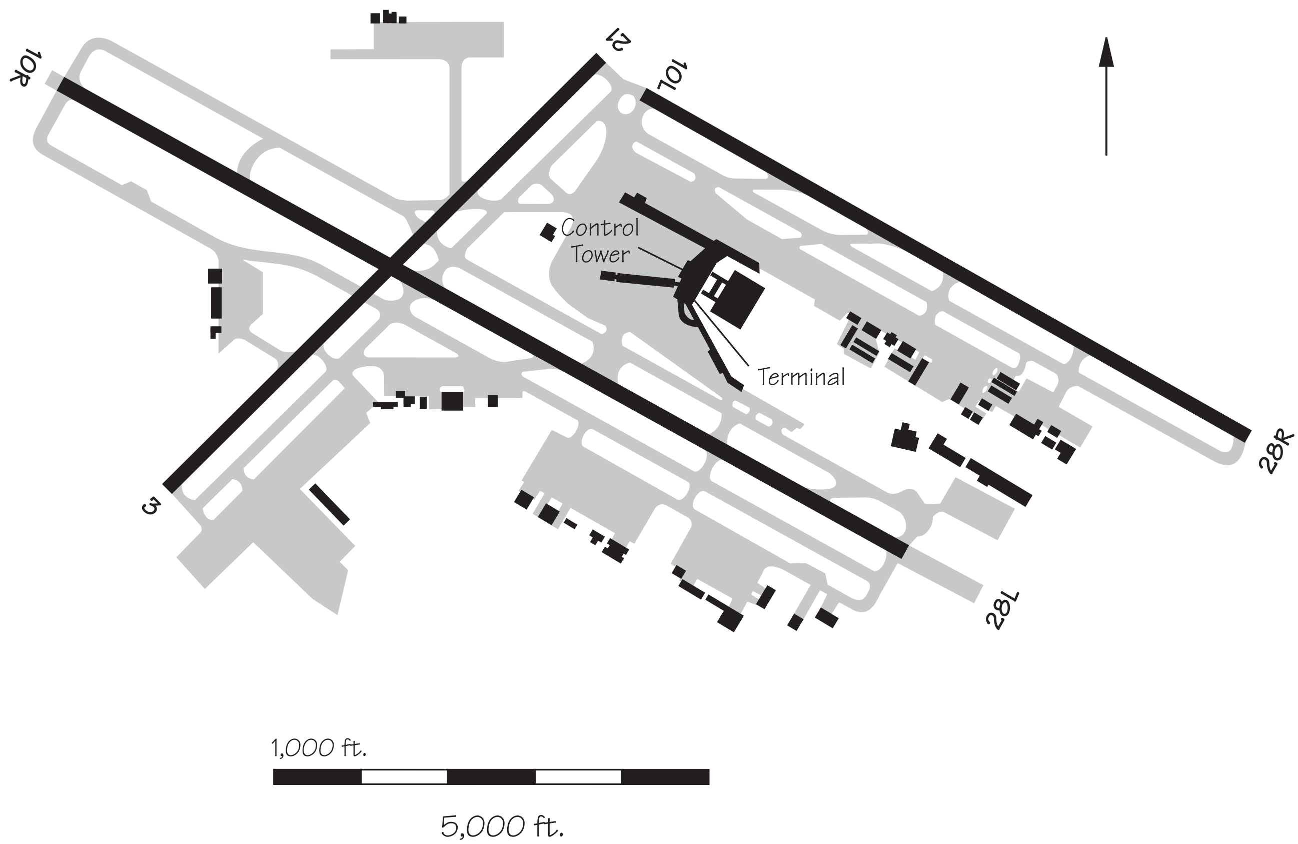


PBI — Palm Beach International Airport

Runway 9L/27R is planned to be extended 1,200 feet to the west and 811 feet to the east, for a total length of 10,000 feet. The total estimated project cost is $10 million. The EIS is planned to be completed in late 1998. Construction is planned to start in 1999 and be completed in 2000.

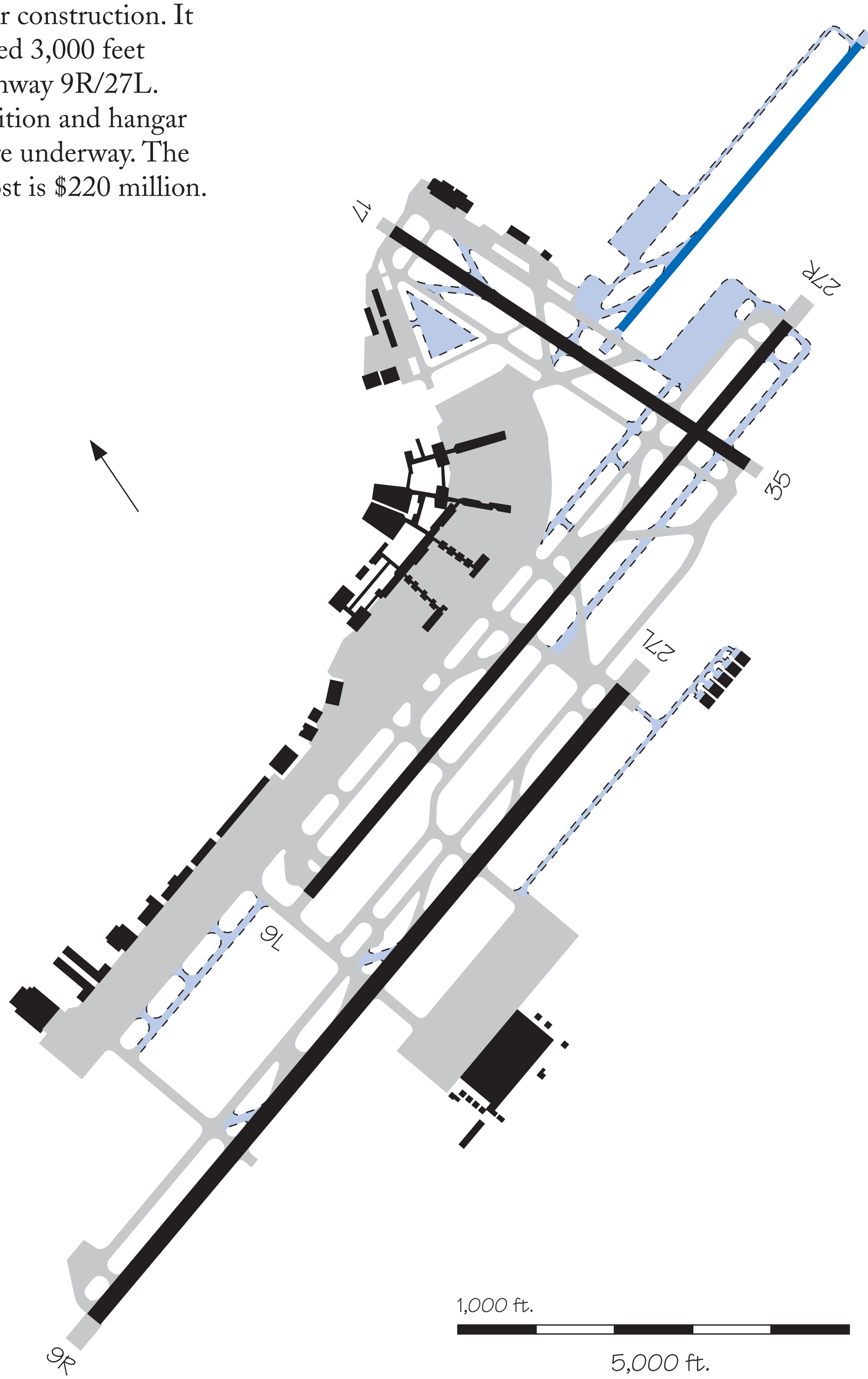


PDX — Portland International Airport



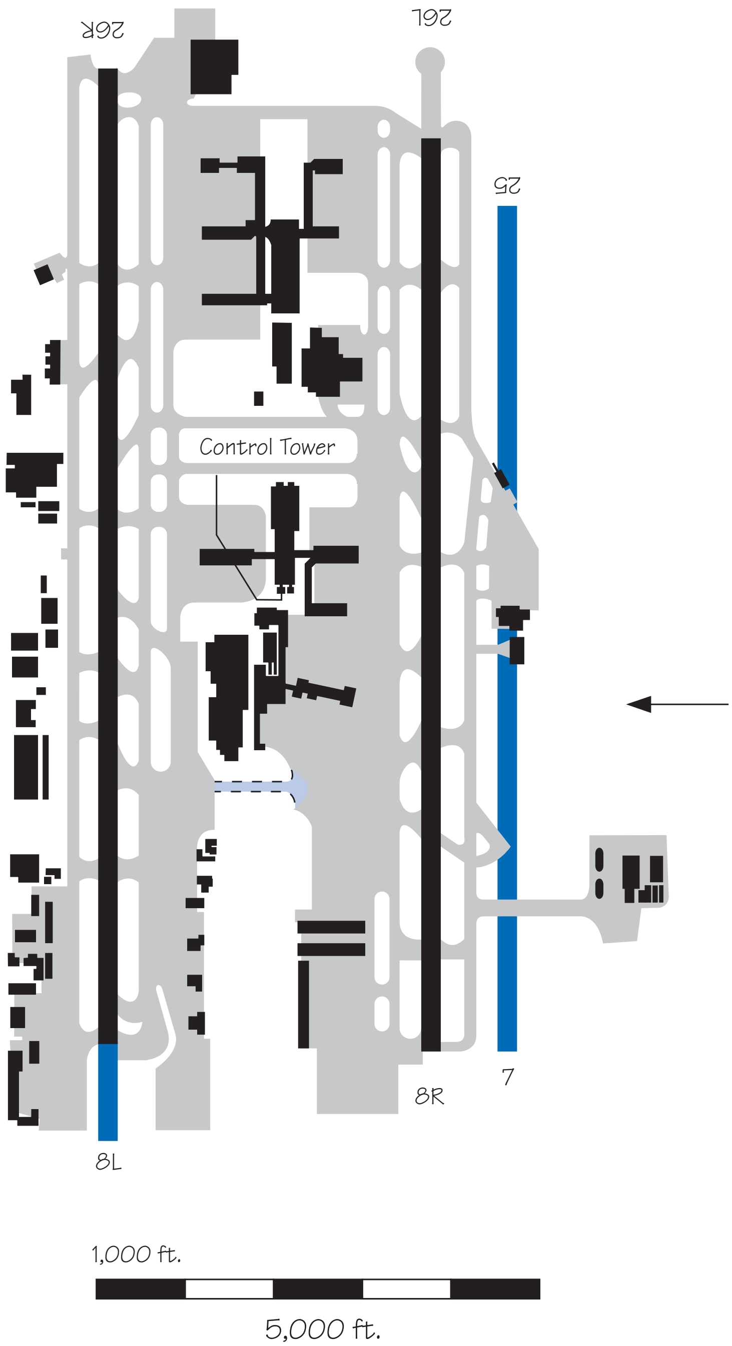
PHL — Philadelphia International Airport

A new 5,000-foot parallel commuter runway, Runway 8/26 is under construction. It will be located 3,000 feet north of Runway 9R/27L. Land acquisition and hangar relocation are underway. The estimated cost is $220 million.



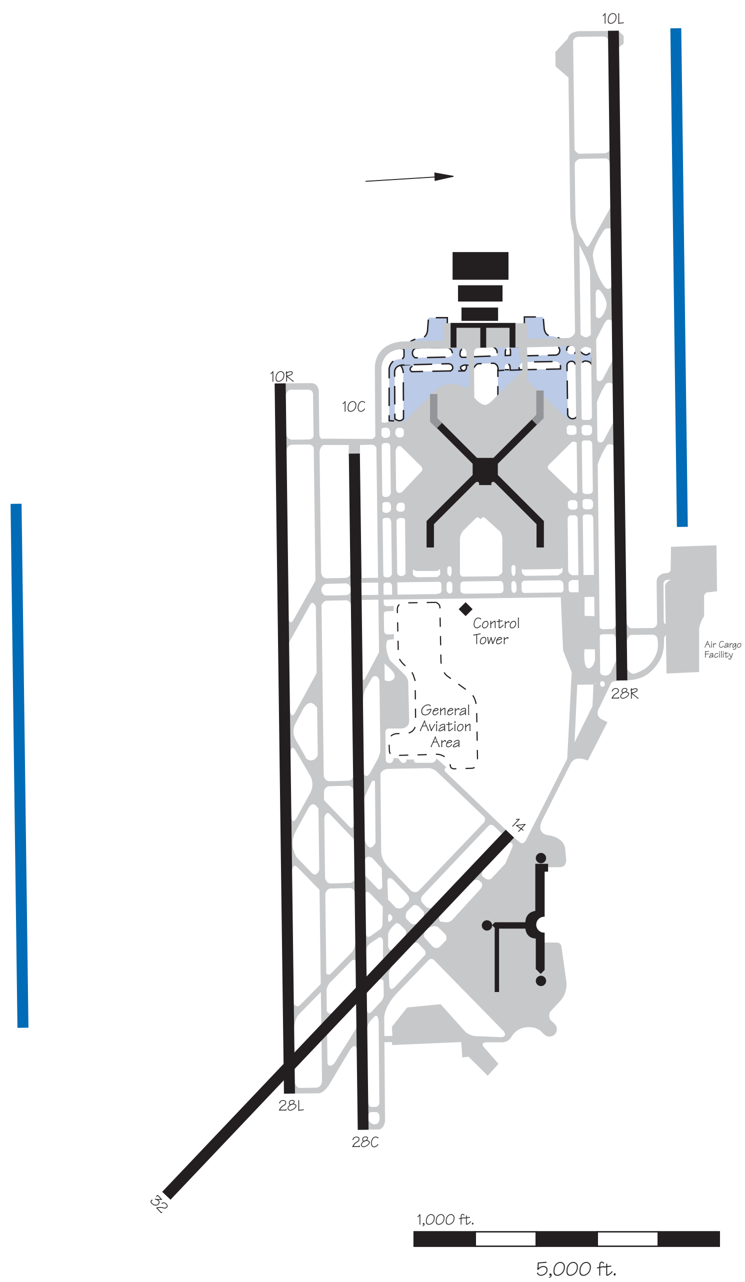
PHX — Phoenix Sky Harbor International Airport

A new third parallel runway, Runway 7/25, is currently under construction 800 feet south of Runway 8R/26L. The planned operational date is September 1999. Runway 7/25 is being constructed to a length of 7,800 feet. The airport layout plan proposes an ultimate length of 9,500 feet, but further construction is not scheduled at this time.

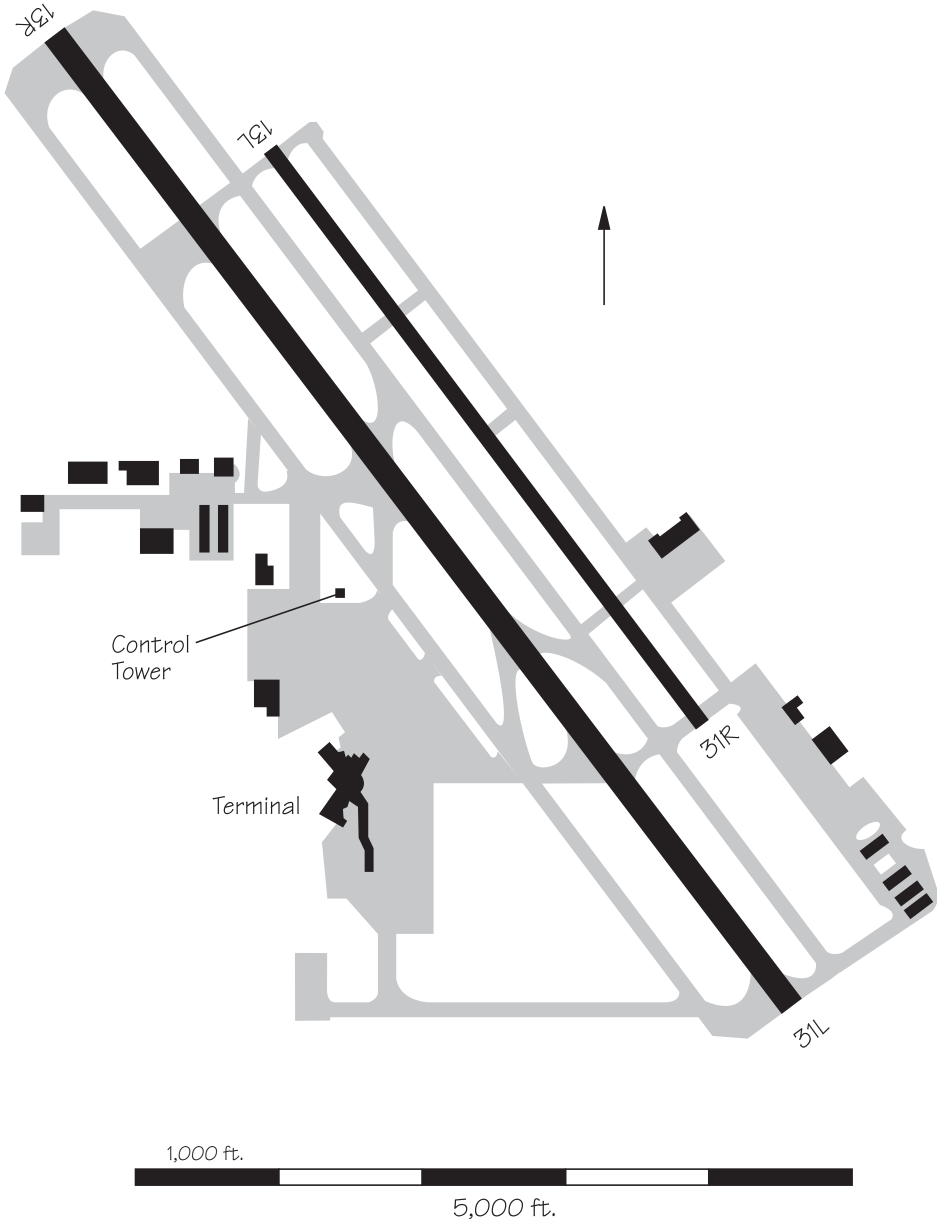


PIT — Greater Pittsburgh International Airport

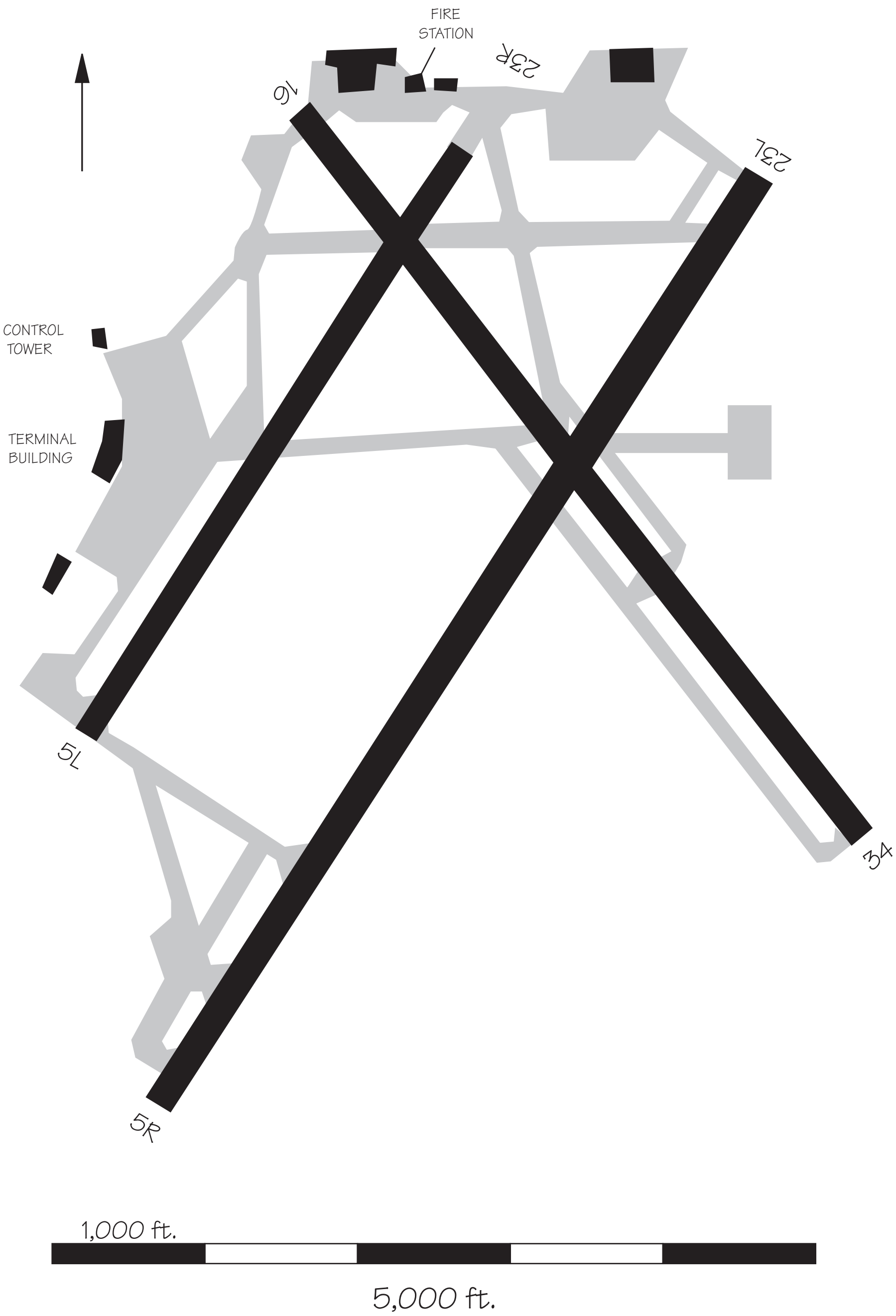
A recently completed Master Plan has recommended that at least two new runways will be needed within a twenty year planning period to accommodate projected Baseline (normal growth) forecast demands and achieve acceptable aircraft delay times and associated delay costs. Construction of the two east/west runways include a northern parallel and a southern parallel, with the latter as the preferred first-build runway. The southern parallel will be located approximately 4,300 feet south of existing Runway 10R/28L and should be operational by the time the airport reaches 495,000 annual aircraft operations. The northern parallel runway will be located 1,000 feet north of existing Runway 10L/28R and should be operational by the time the airport reaches 522,000 annual aircraft operations.



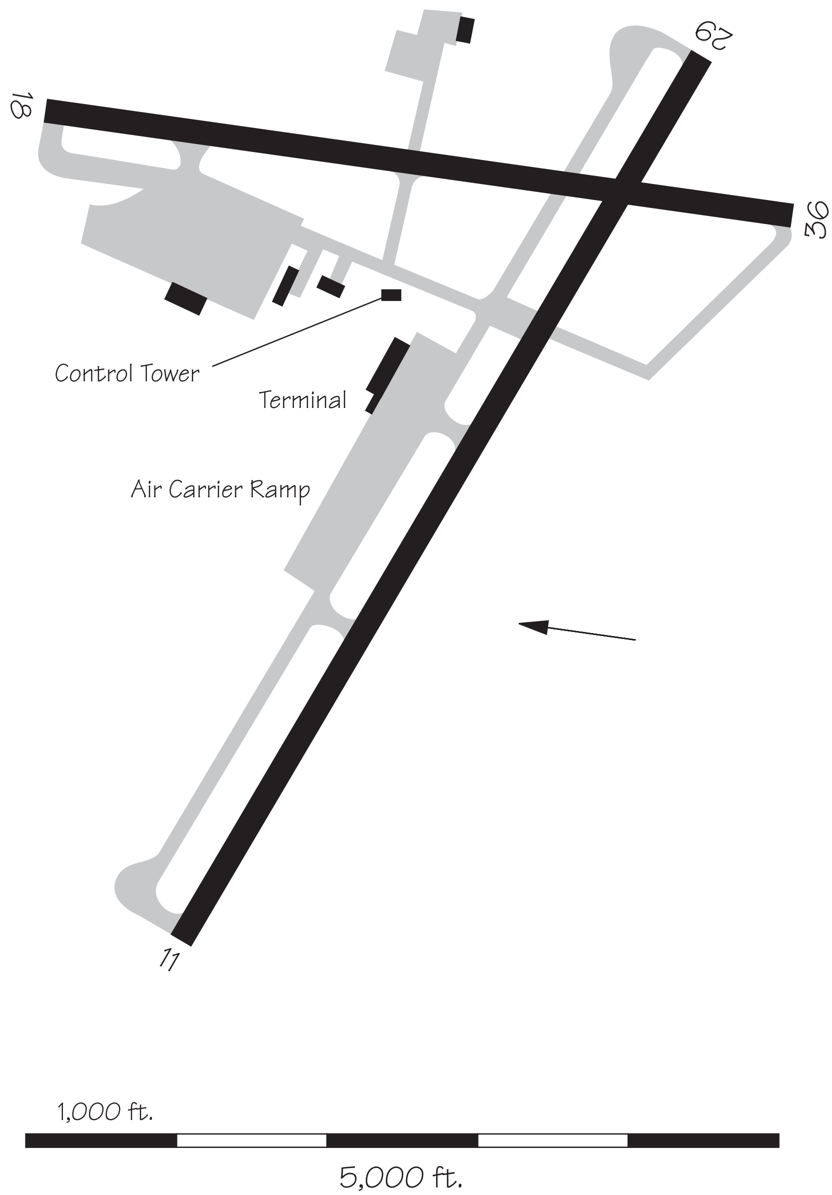
PSP — Palm Springs Regional Airport



PVD — Providence Theodore Francis Green State Airport



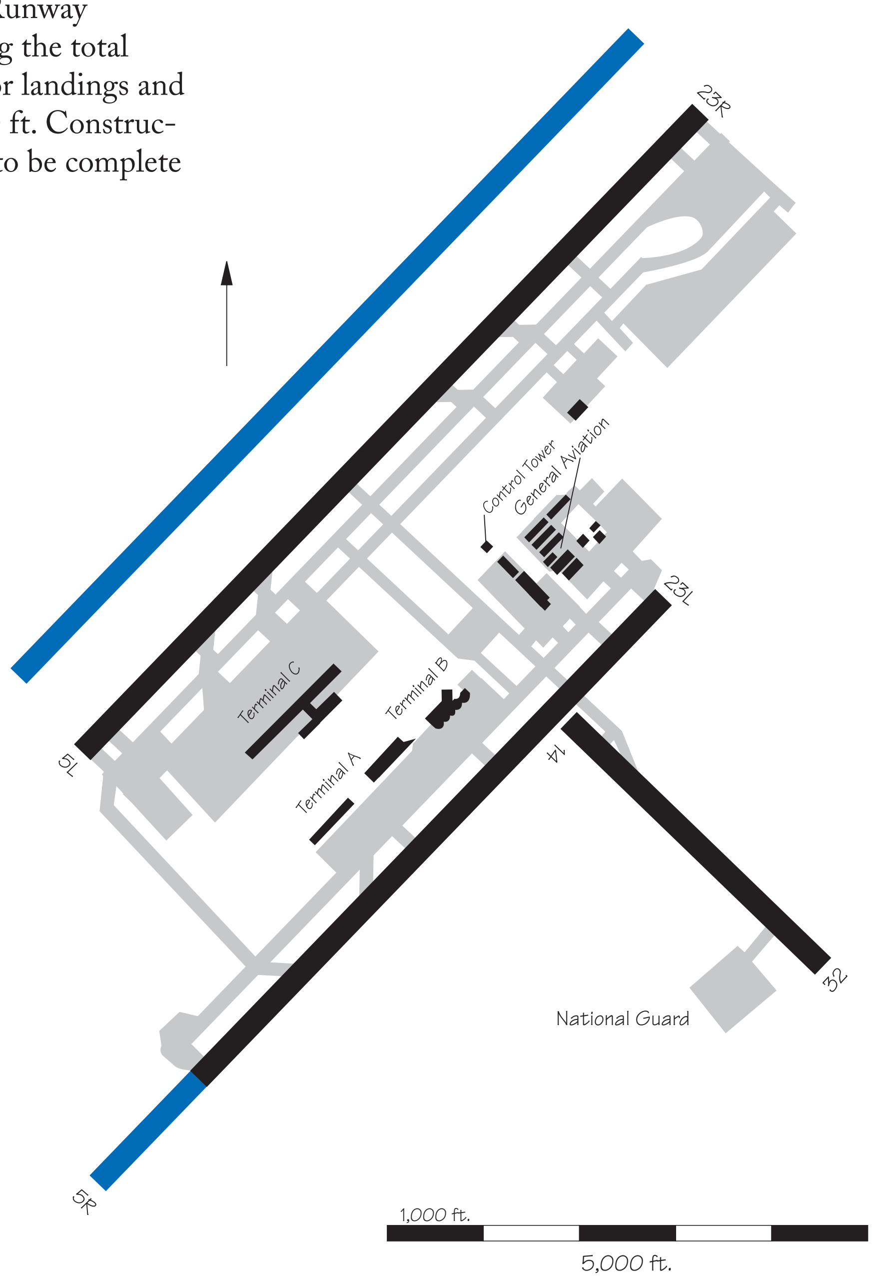
PWM — Portland International Jetport



RDU — Raleigh-Durham International Airport

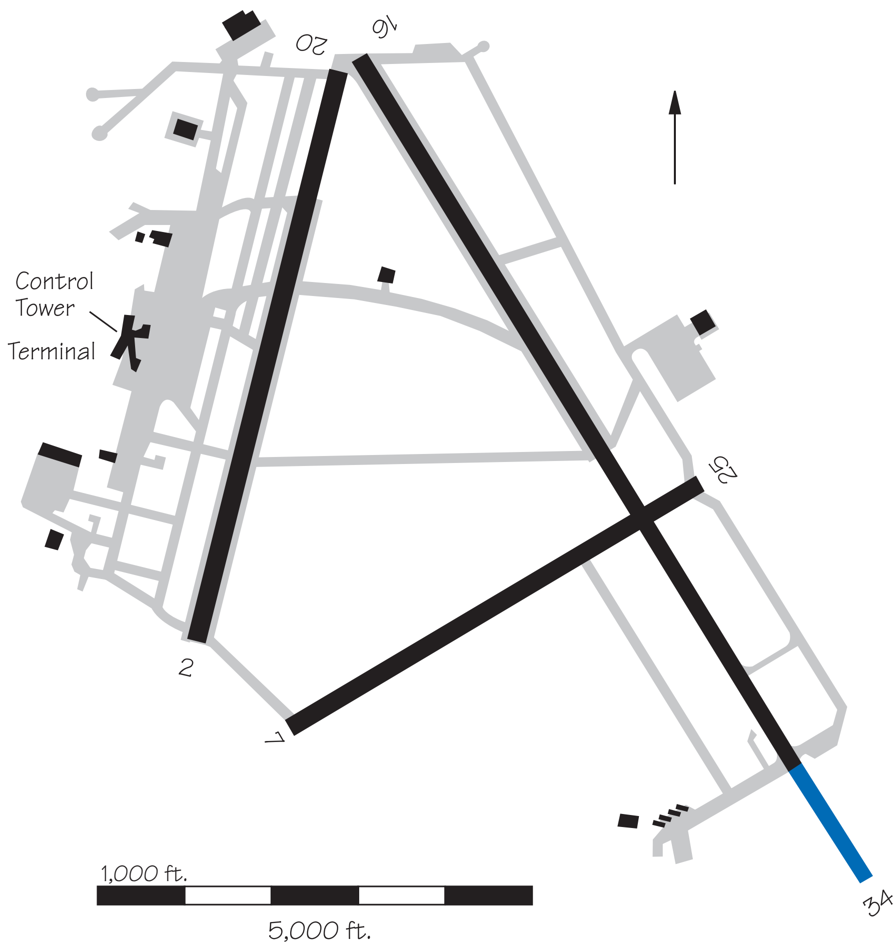
A new 9,500 ft. parallel runway located approximately 1,050 feet west of existing Runway 5L/23R is planned for the future.

Also planned is a 1,500 ft. runway extension to the south end of existing Runway 5R/23L, bringing the total useable length for landings and takeoffs to 9,000 ft. Construction is expected to be complete in 2005.

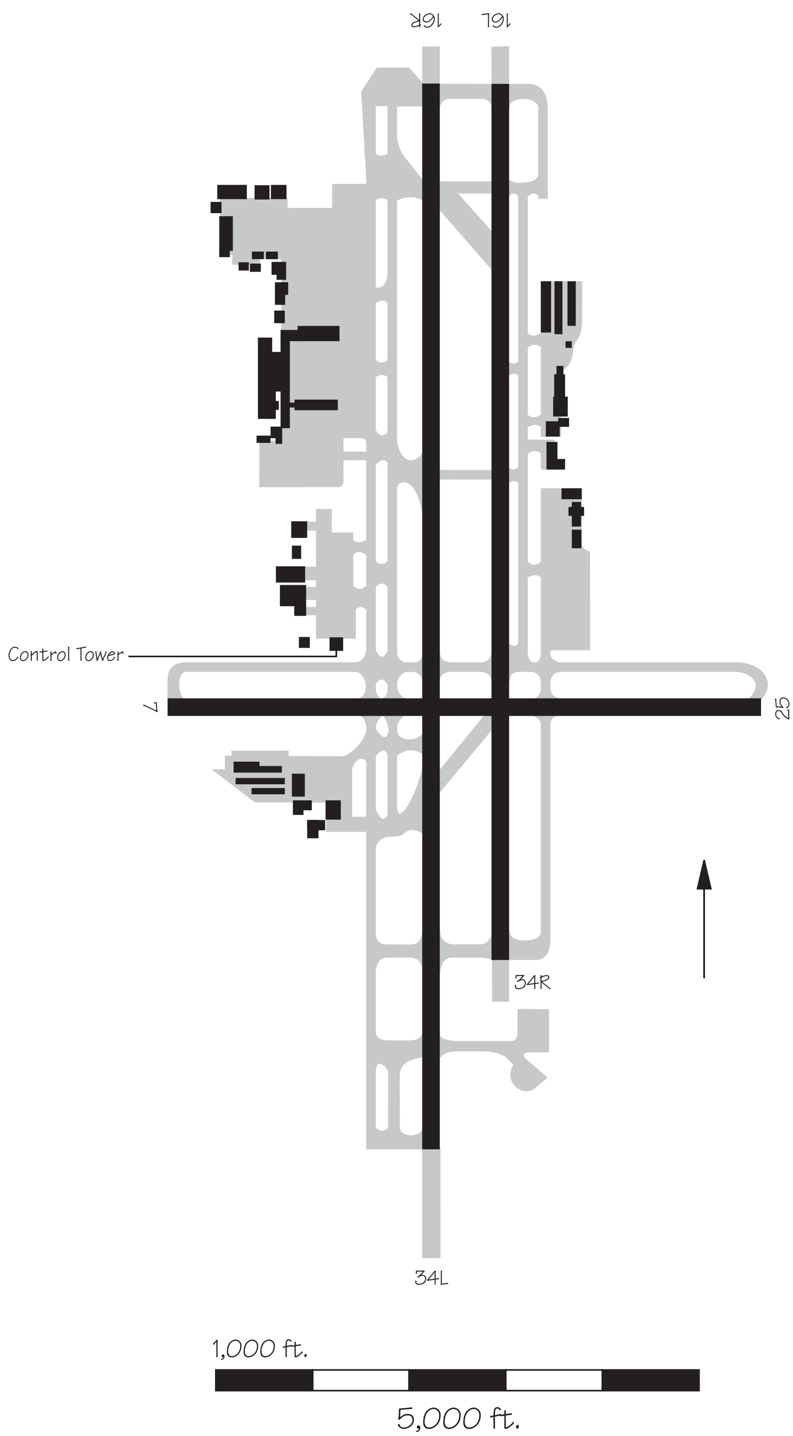


RIC — Richmond International Airport

An extension of Runway 16/34 is under environmental review.

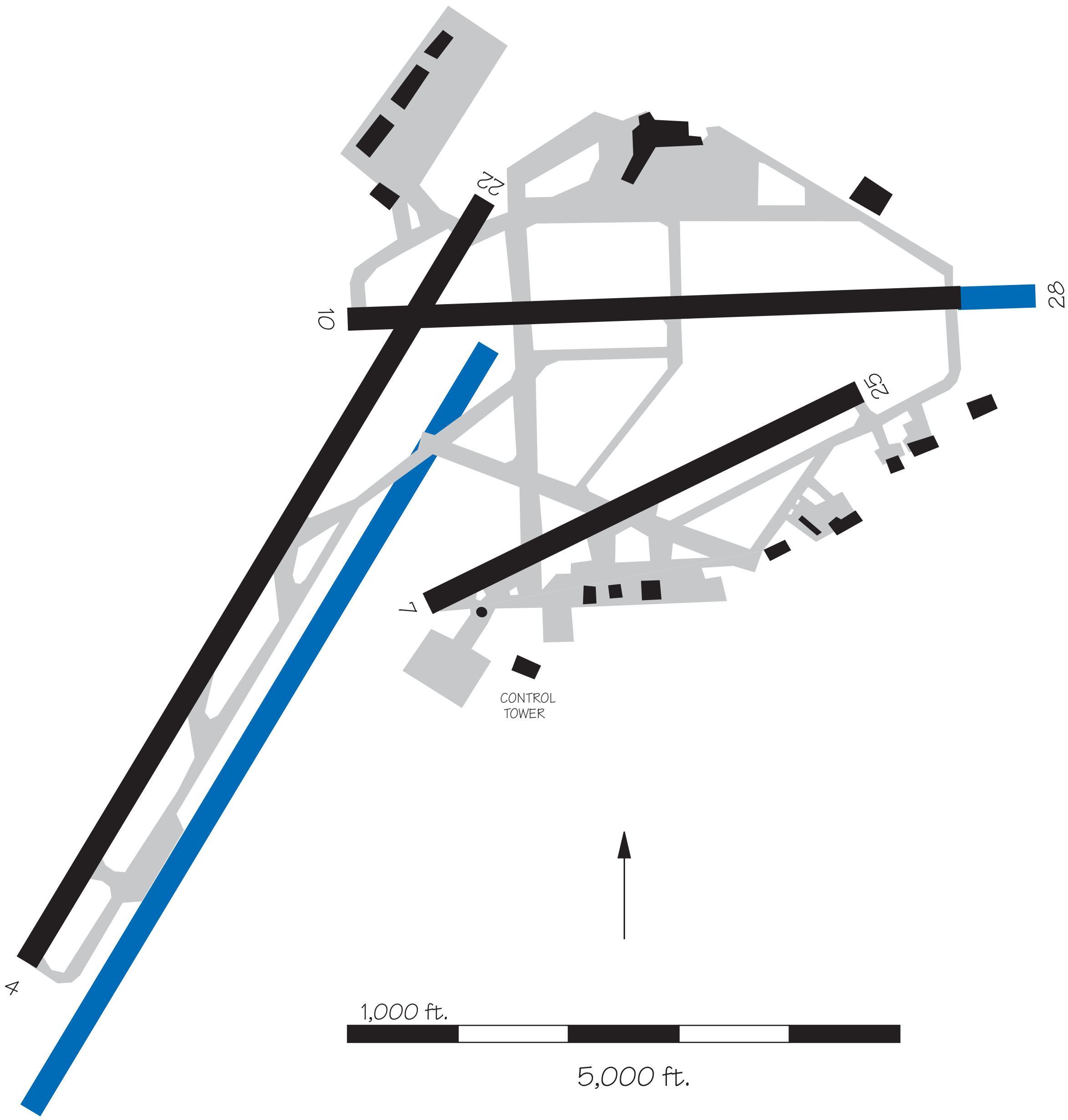


RNO — Reno Tahoe International Airport



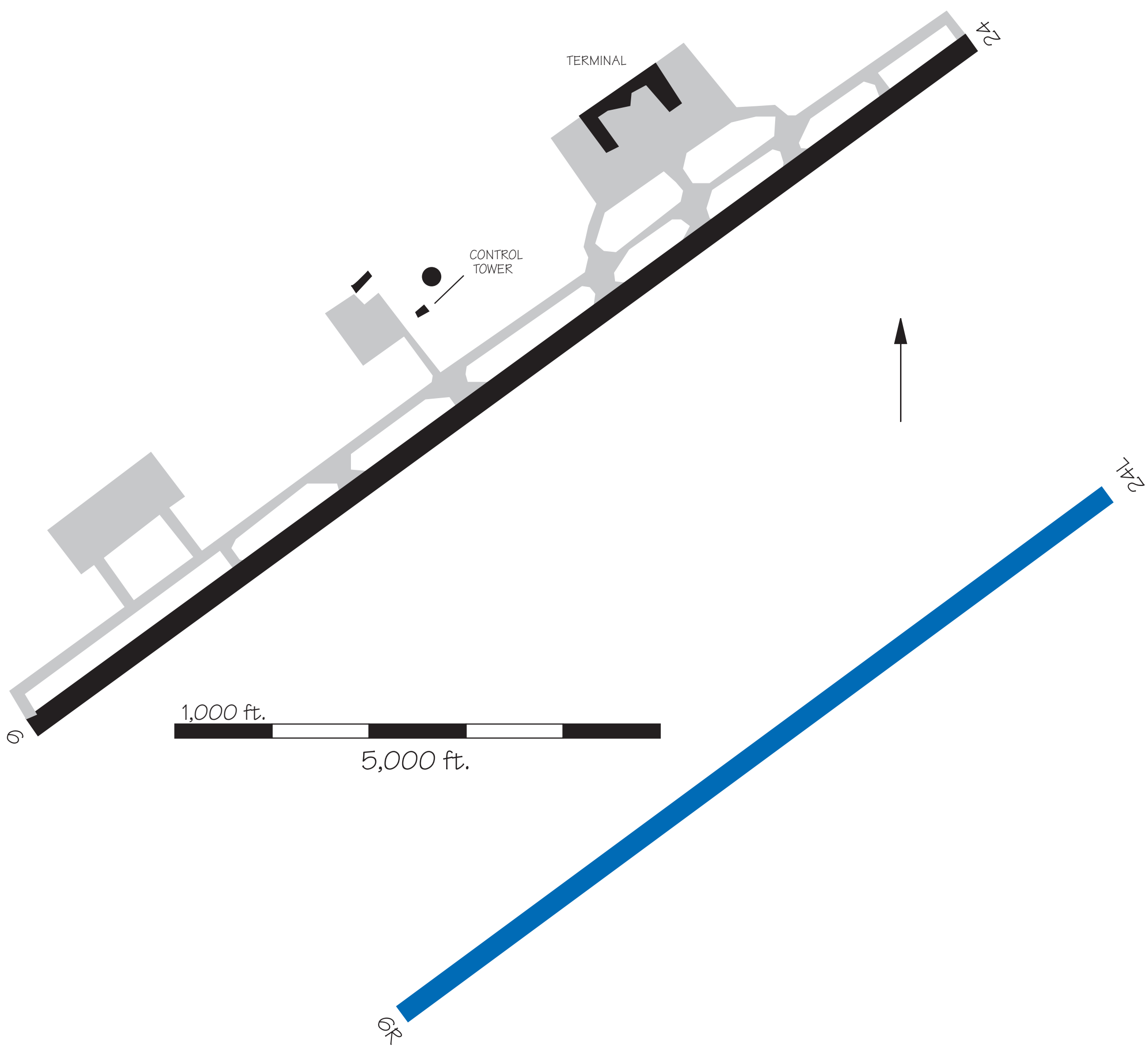
ROC — Greater Rochester International Airport

Construction of an extension to Runway 10/28 is being considered. The estimated cost of construction is $3.2 million. An extension to Runway 4/22 is also being considered, and is expected to cost $4 million. Construction of a new parallel Runway 4R/22L 700 feet southeast of Runway 4/22 is estimated to cost $10 million. These runway improvements are anticipated post 2000. Environmental assessments have not yet been started for these projects.

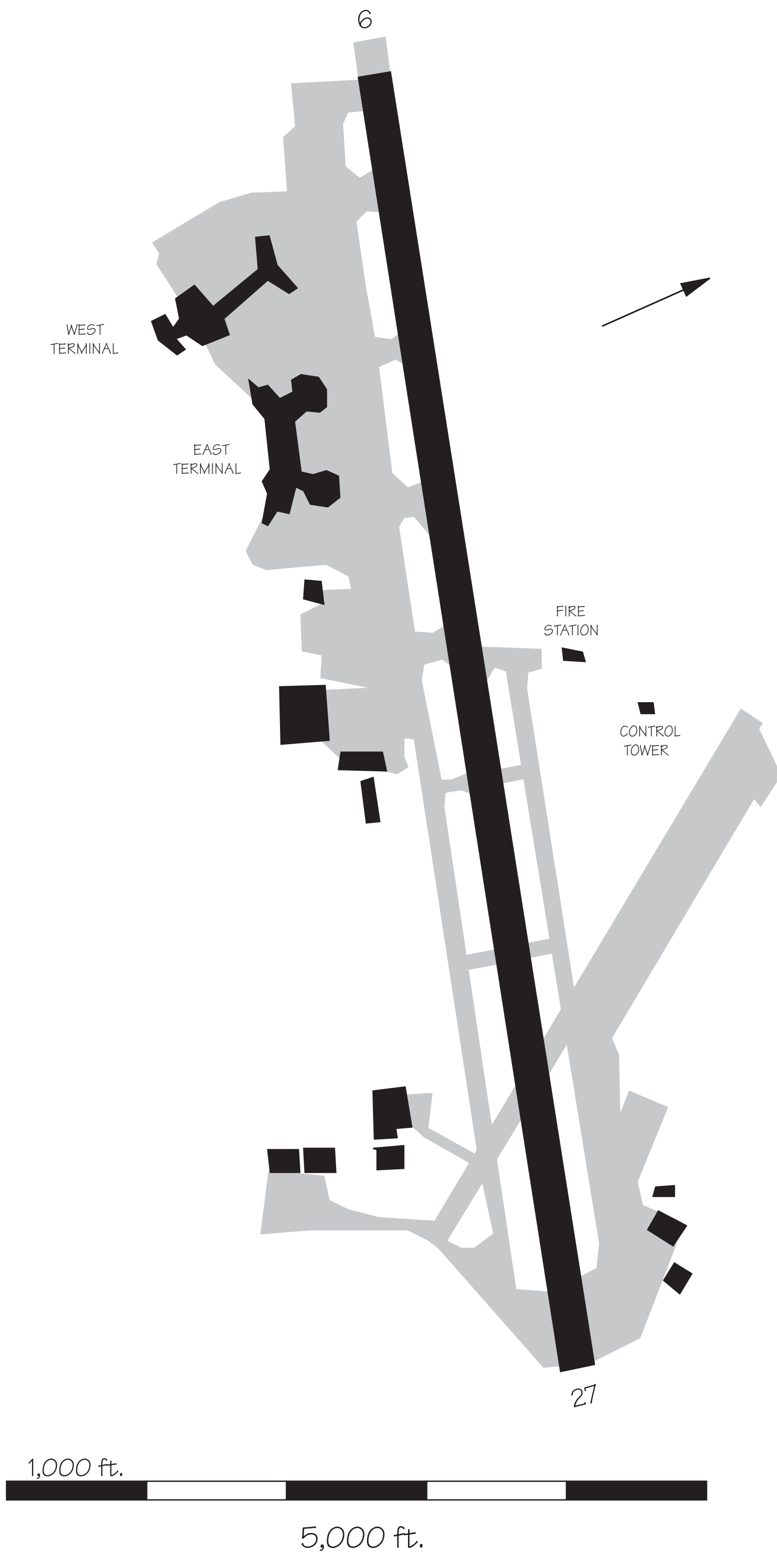


RSW — Fort Myers Southwest Florida Regional Airport

Planning has begun for a new 9,100 foot parallel runway, Runway 6R/24L, 4,300 feet or more southeast of Runway 6/24. Construction is expected to begin in 2000. The new runway should be operational by 2002. The estimated cost of the project is $80 million. This new runway will support independent parallel operations.

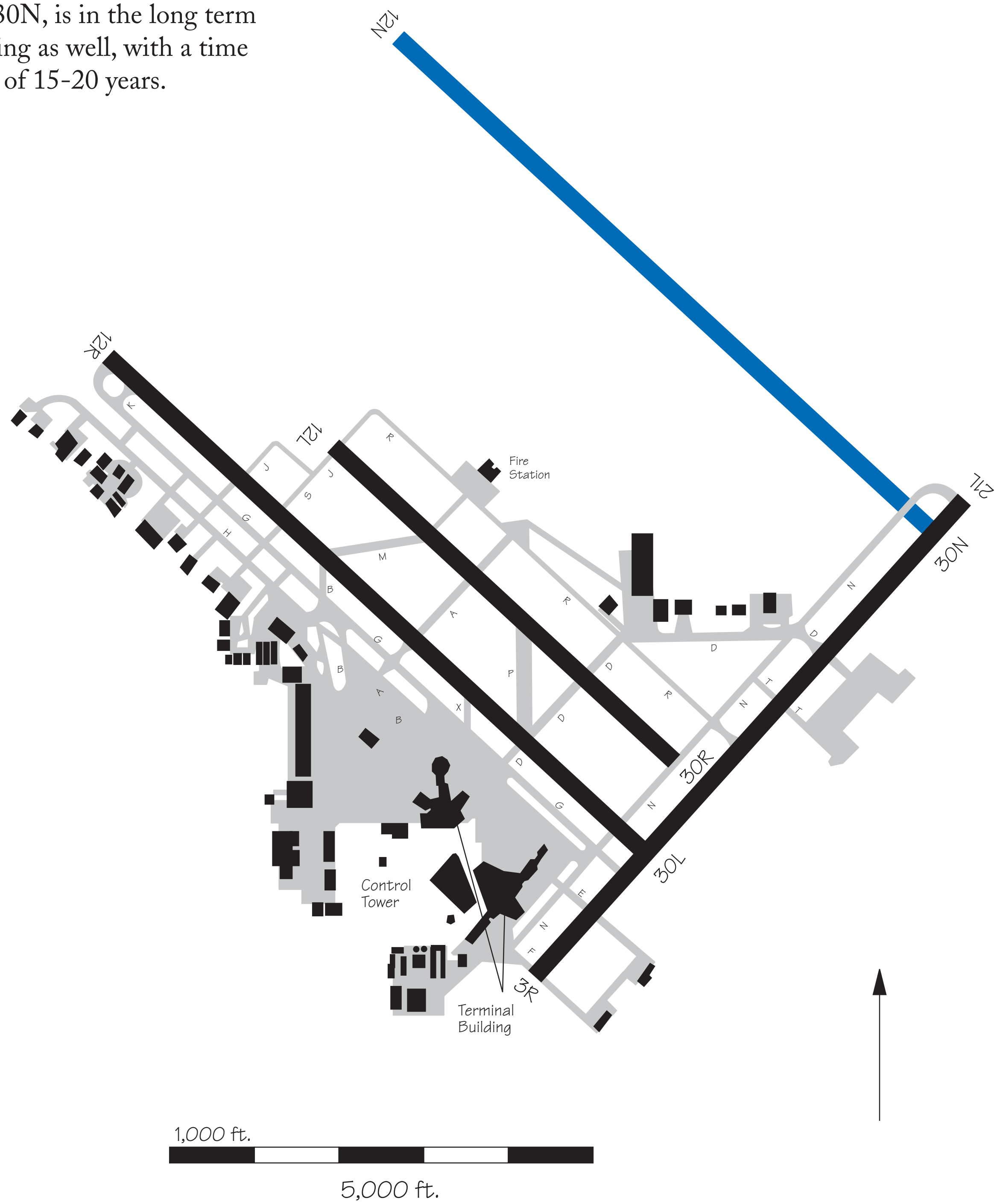


SAN — San Diego International Lindberg Field



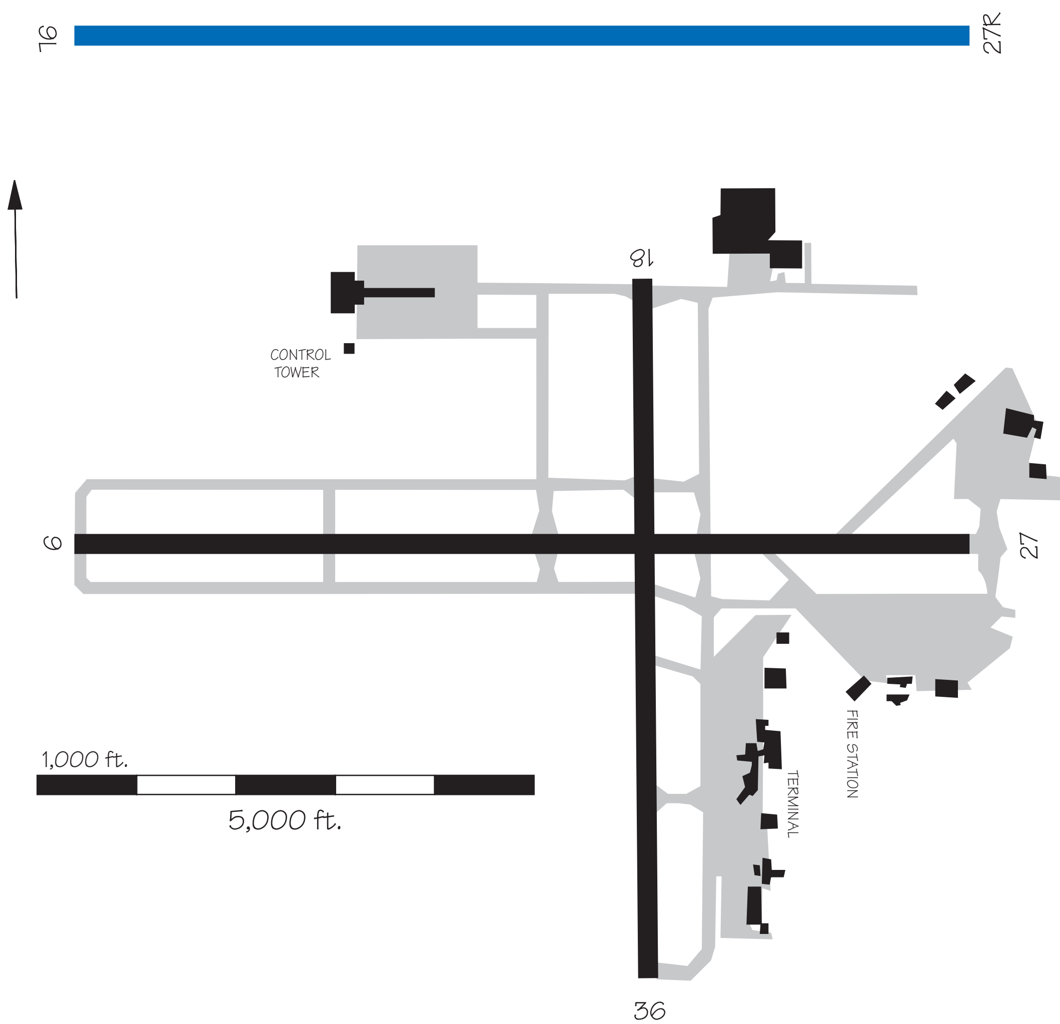
SAT — San Antonio International Airport

Reconstruction and extension of Runway 12L/30R for air carrier operations is being planned for beyond 2000, as demand warrants. A third parallel runway, Runway 12N/30N, is in the long term planning as well, with a time frame of 15-20 years.



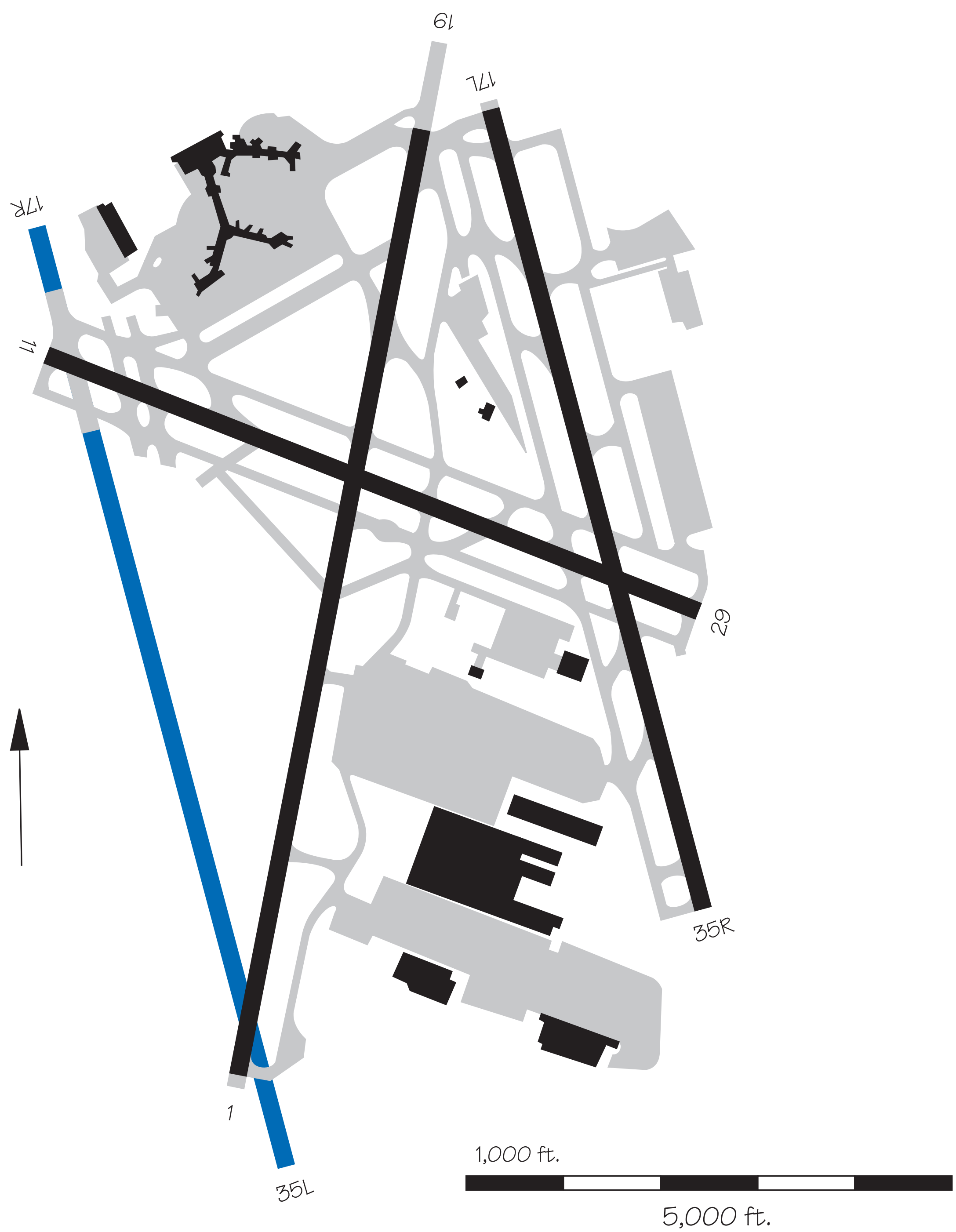
SAV — Savannah International Airport

A new 9,000-foot parallel runway, Runway 9L/27R, approximately 5,000 feet north of Runway 9/27, is expected to be constructed in 2020, with an estimated cost of $20 million.



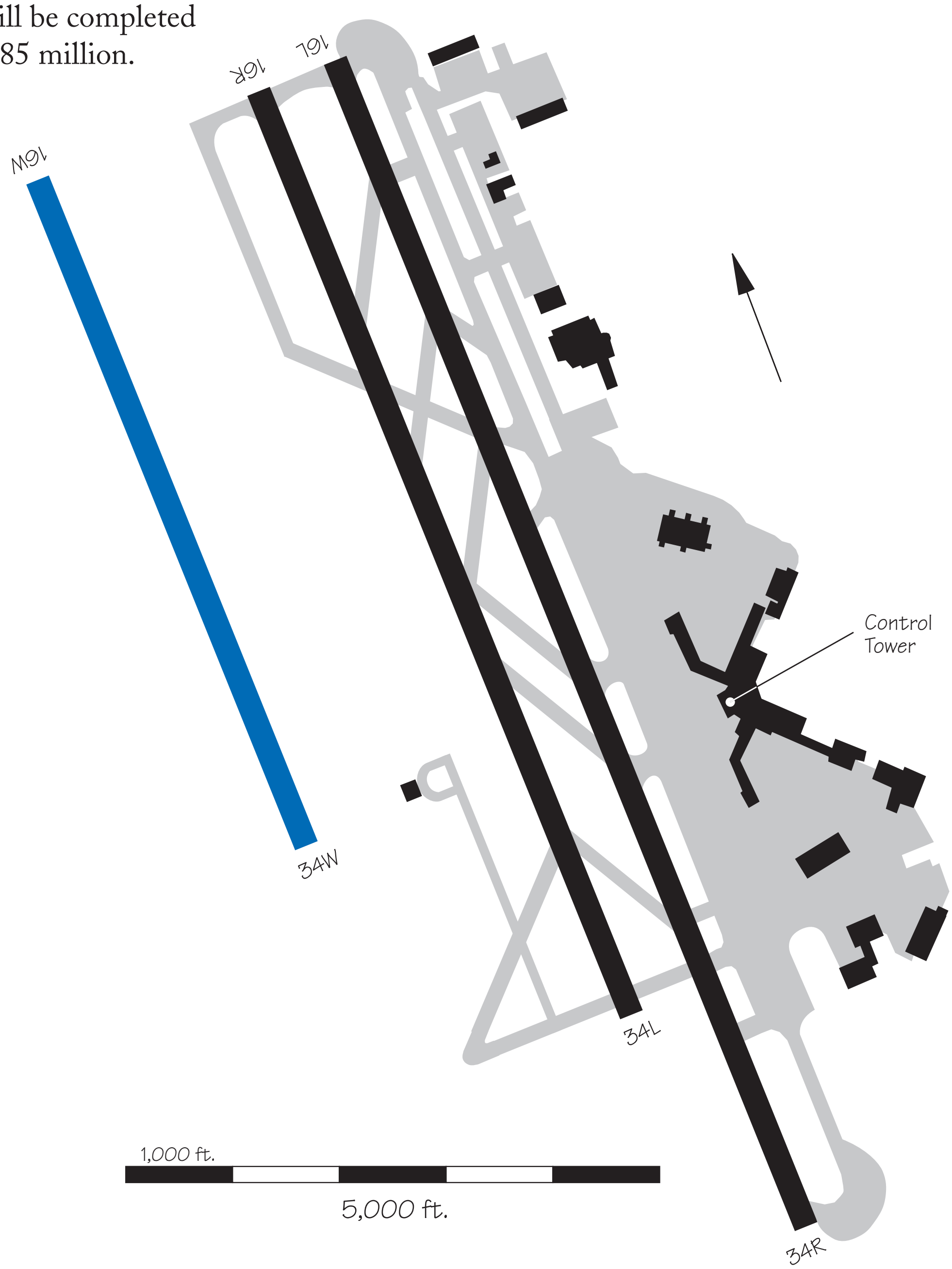
SDF — Louisville International Airport

Construction is underway for two new parallel runways, 4,950 feet apart. They will be numbered Runways 17R/35L and 17L/35R and will be 10,000 and 8,580 feet long, respectively. They will replace Runway 1/19, which will be closed. The estimated cost of construction is $59 million for Runway 17R/35L. Runway 17L/35R is complete, and Runway 17R/35L is expected to be completed in 1997. The two runways will permit independent parallel IFR operations.

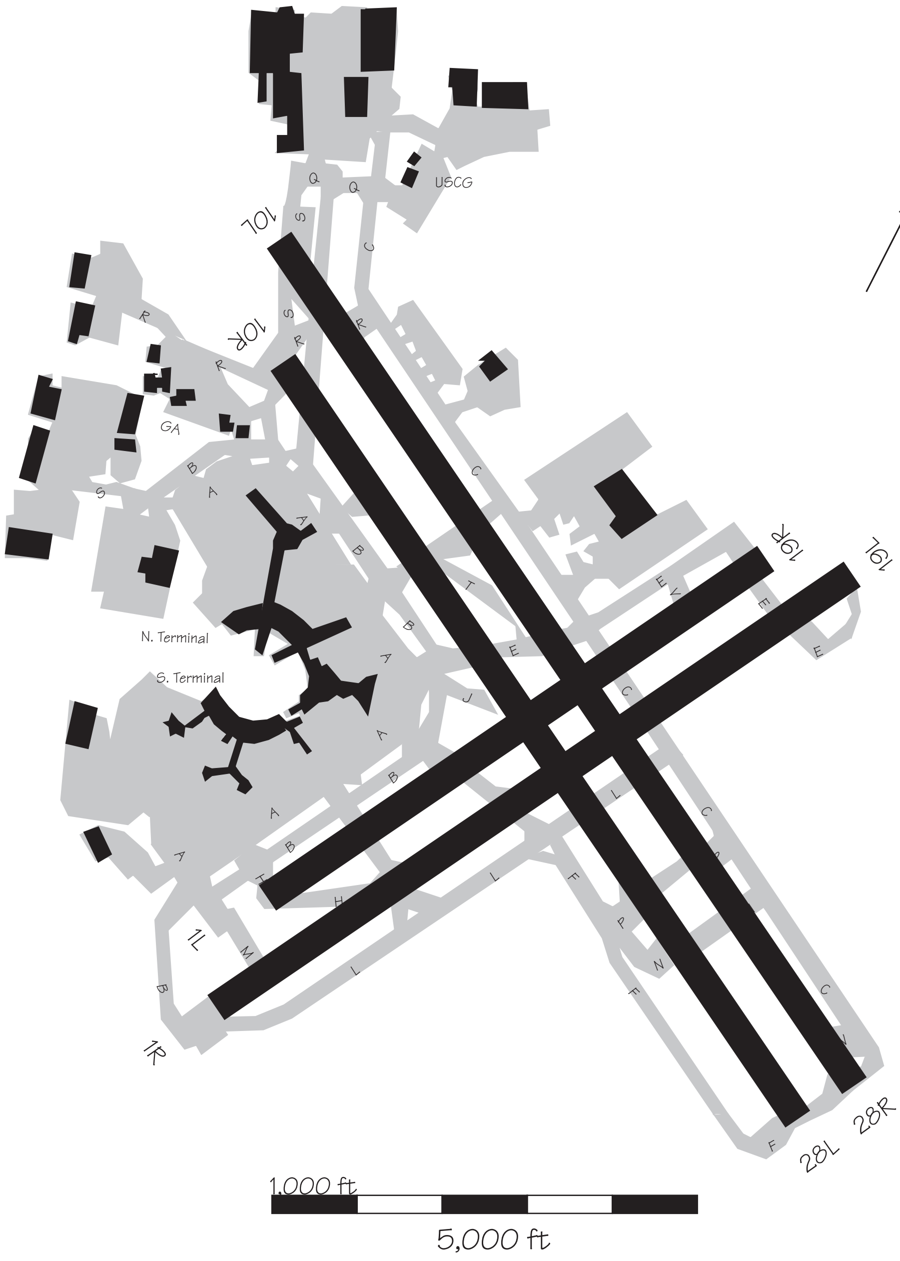


SEA — Seattle-Tacoma International Airport

Airport improvements include a new Runway 16W/34W, 8,500 feet in length, which will be located 2,500 feet from Runway 16L/34R. Construction is scheduled to begin in 1997. The runway will be completed by 2004 for $585 million.

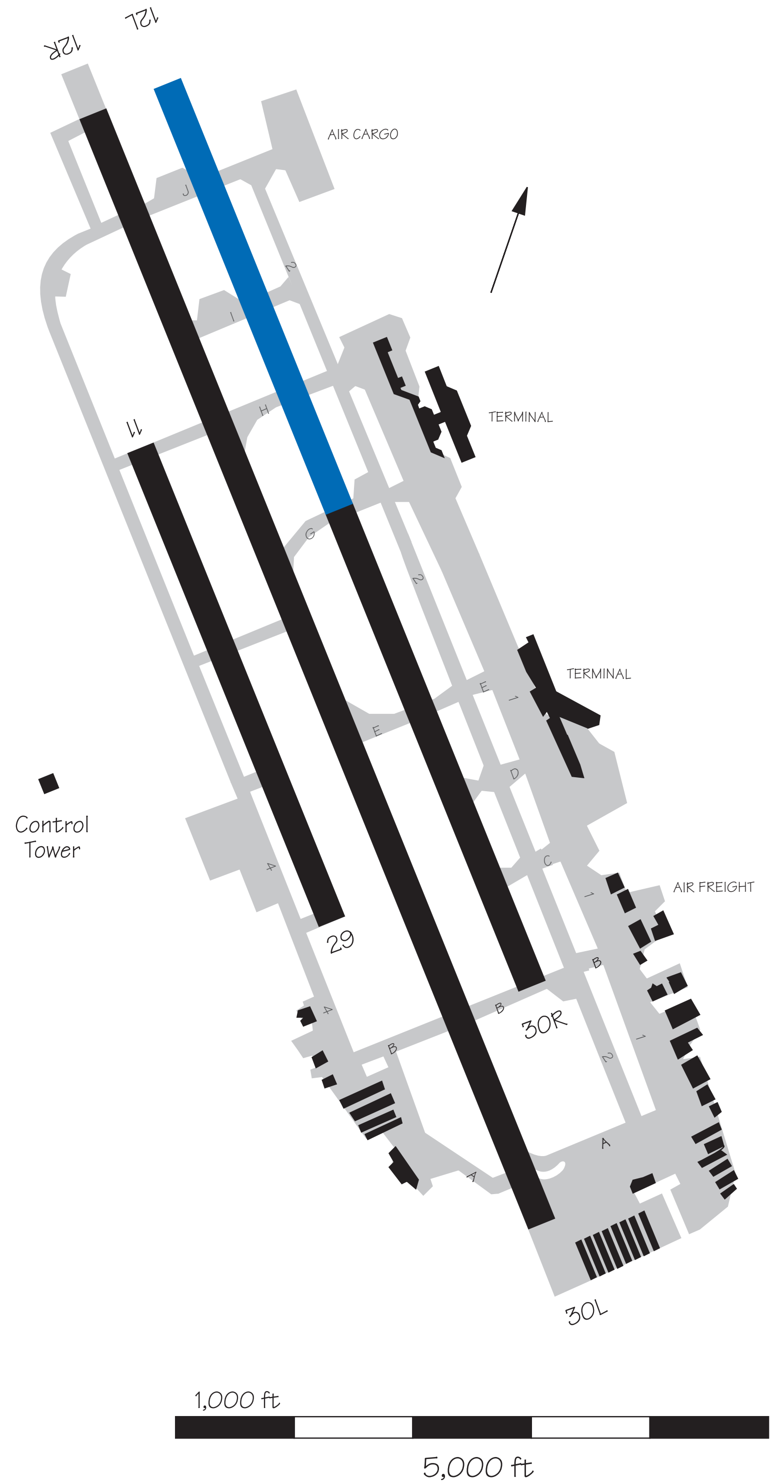


SFO — San Francisco International Airport



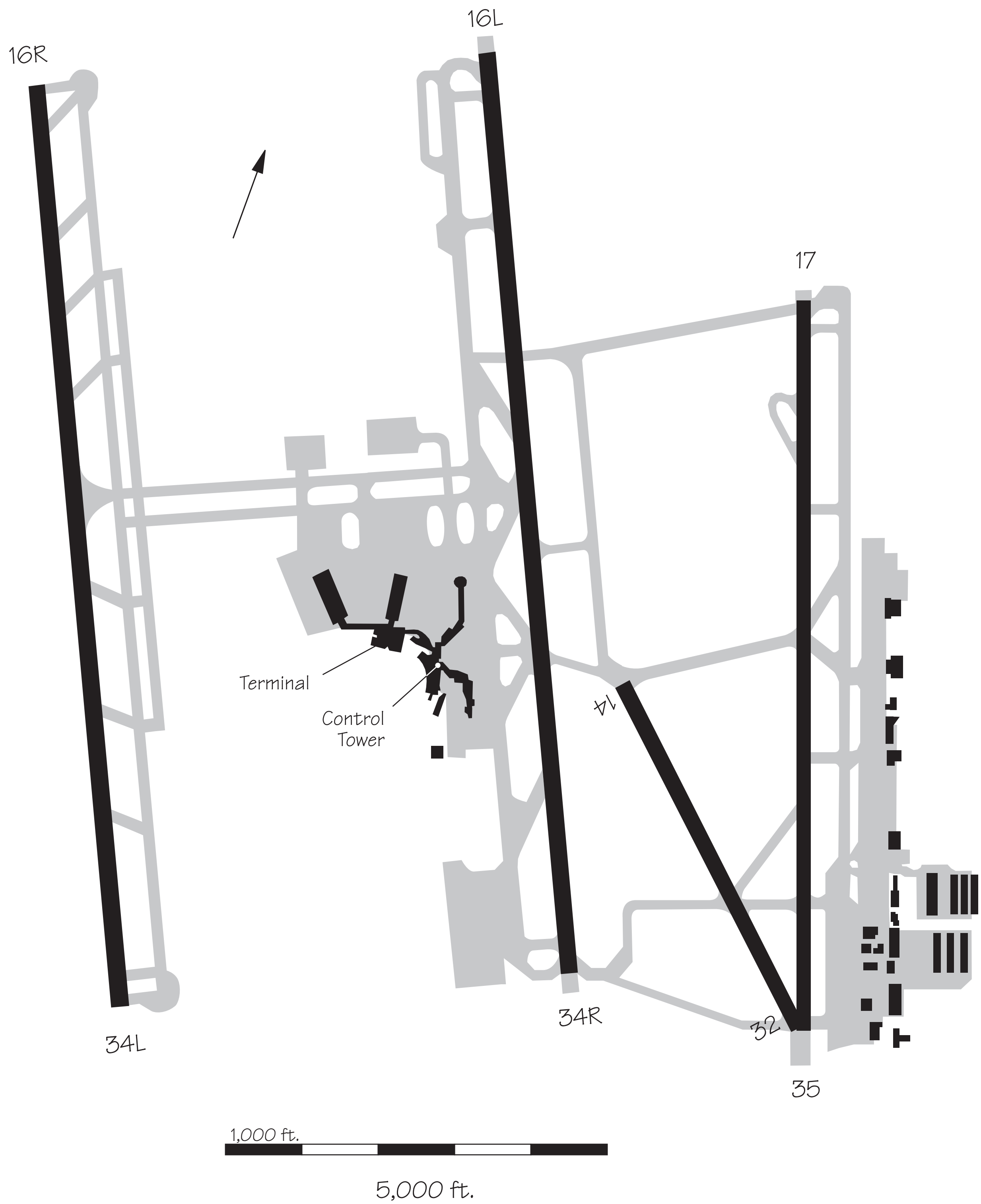
SJC — San Jose International Airport

Environmental documentation is currently being prepared in support of the extension of Runway 12L/30R. If this option is determined to be environmentally acceptable and is adopted by the sponsor, construction will begin in 1997.

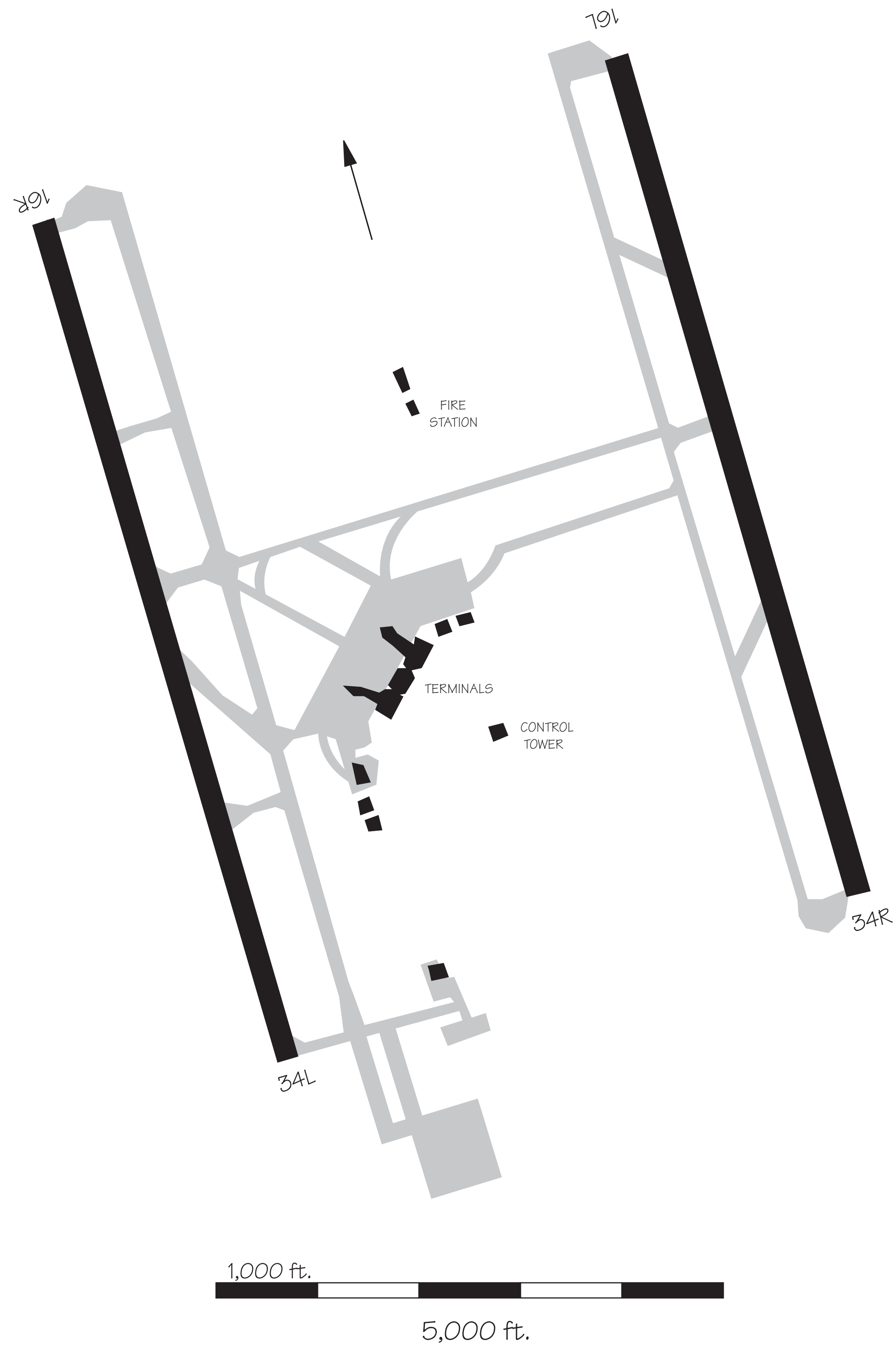


SJU — San Juan Luis Muñoz Marín International Airport

SLC — Salt Lake City International Airport

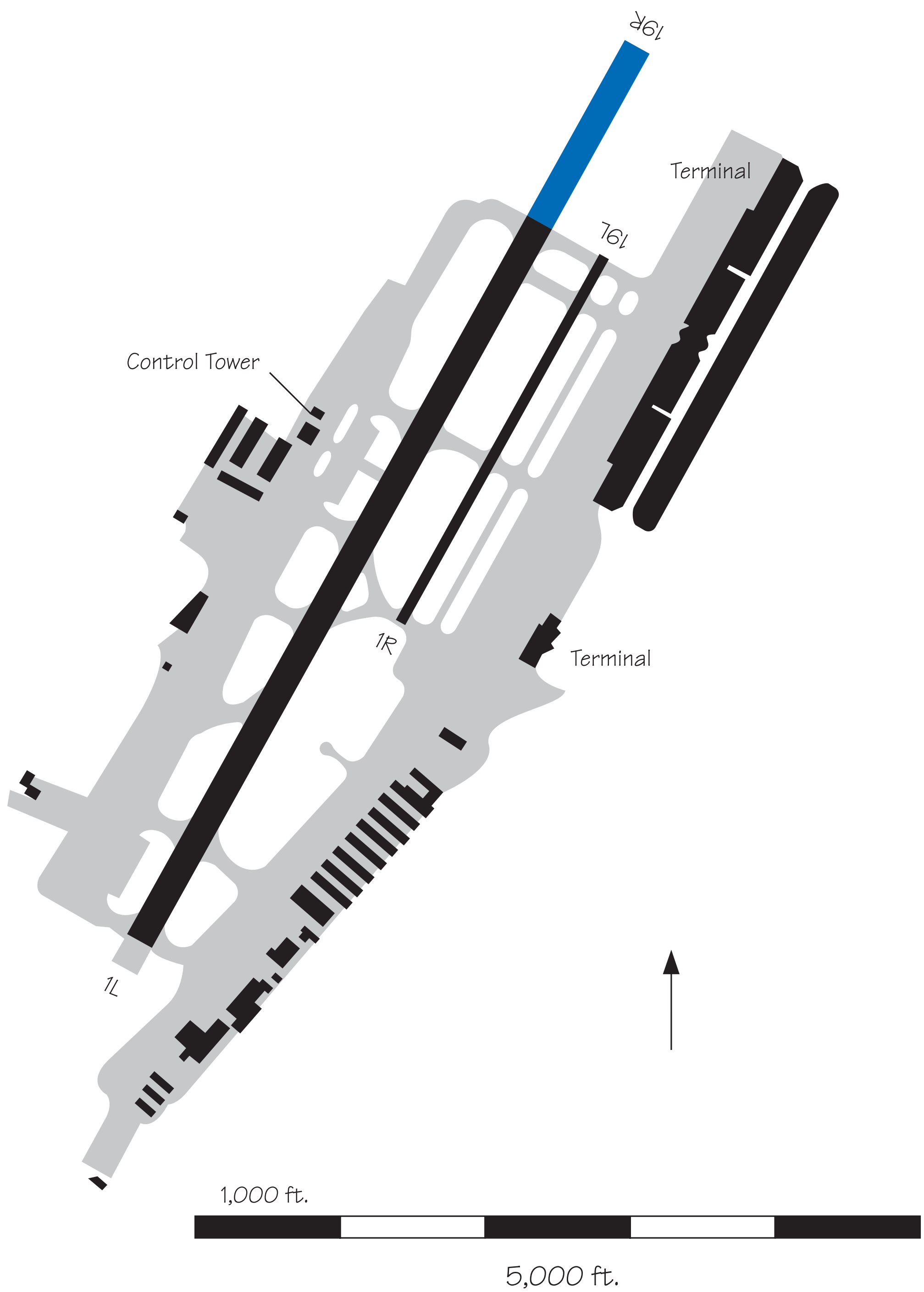


SMF — Sacramento International Airport



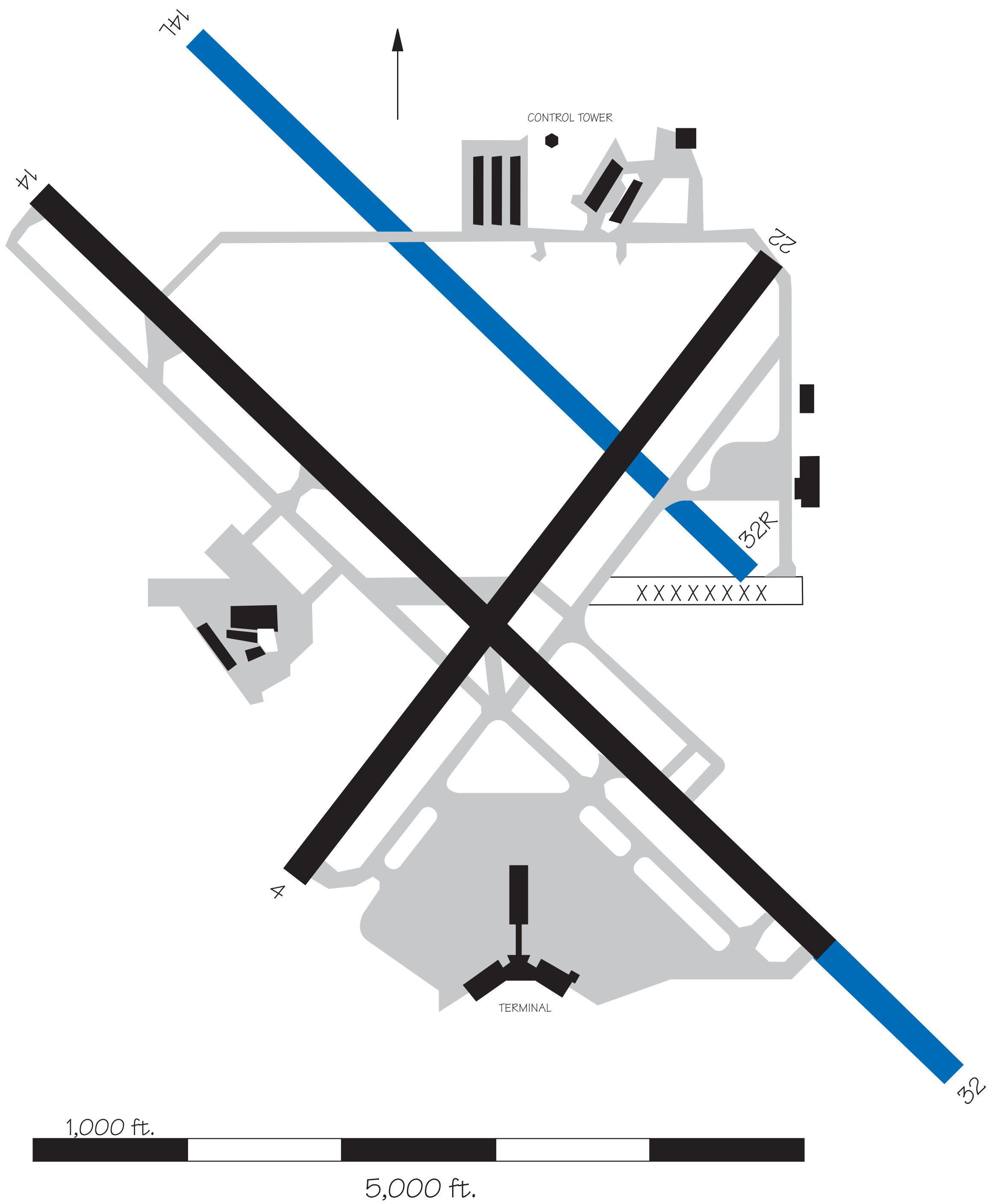
SNA — Santa Ana/John Wayne Airport - Orange County

An extension of Runway 1L/19R is under consideration.



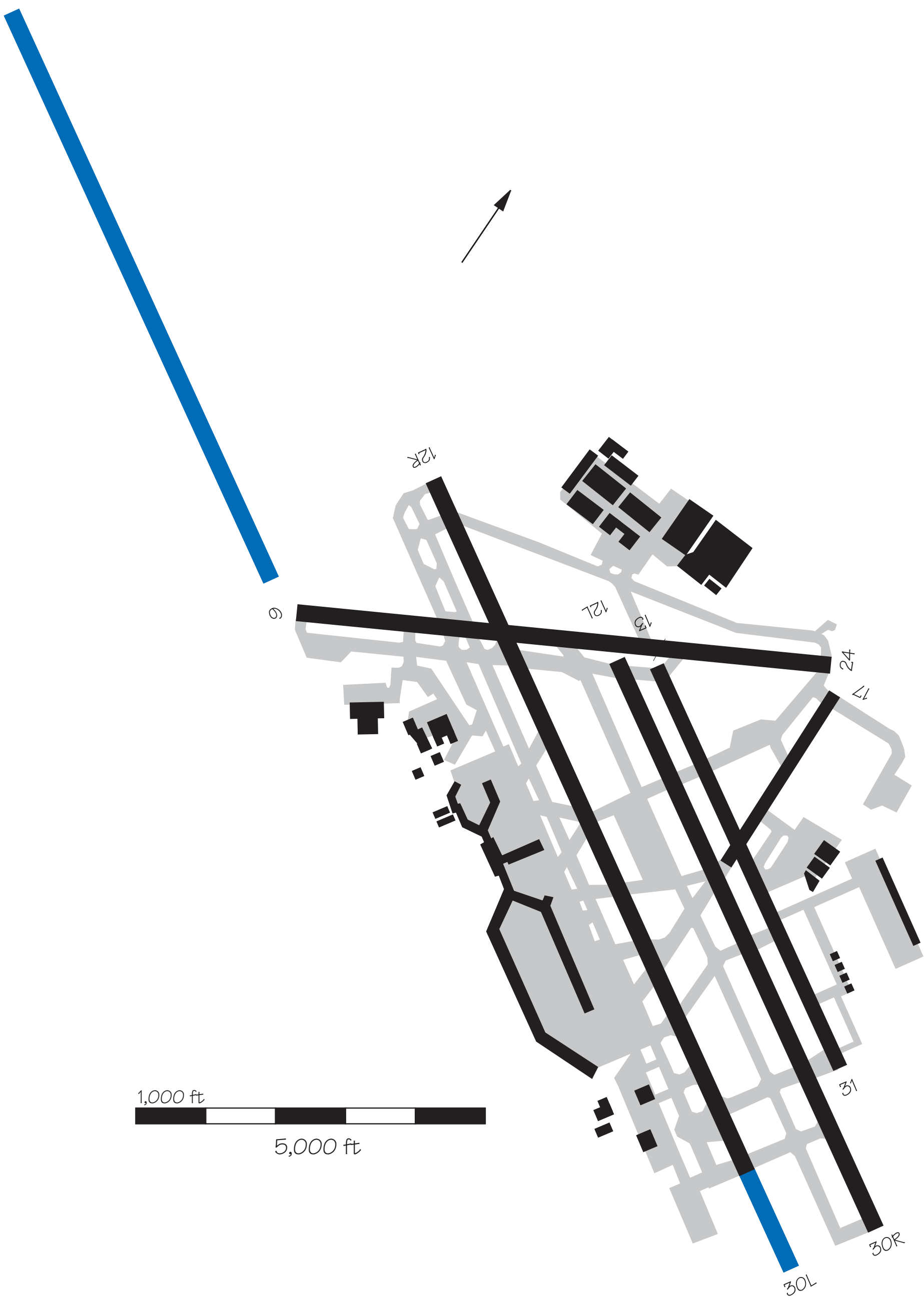
SRQ — Sarasota Bradenton Airport

A new parallel Runway 14L/32R 1,230 feet northwest of Runway 14/32 is being planned at an estimated cost of $10 million. It is expected to be operational beyond 2002. In addition, an extension of the existing Runway 14/32 is planned at a cost of $5.1 million. It is expected to be operational beyond 2002.



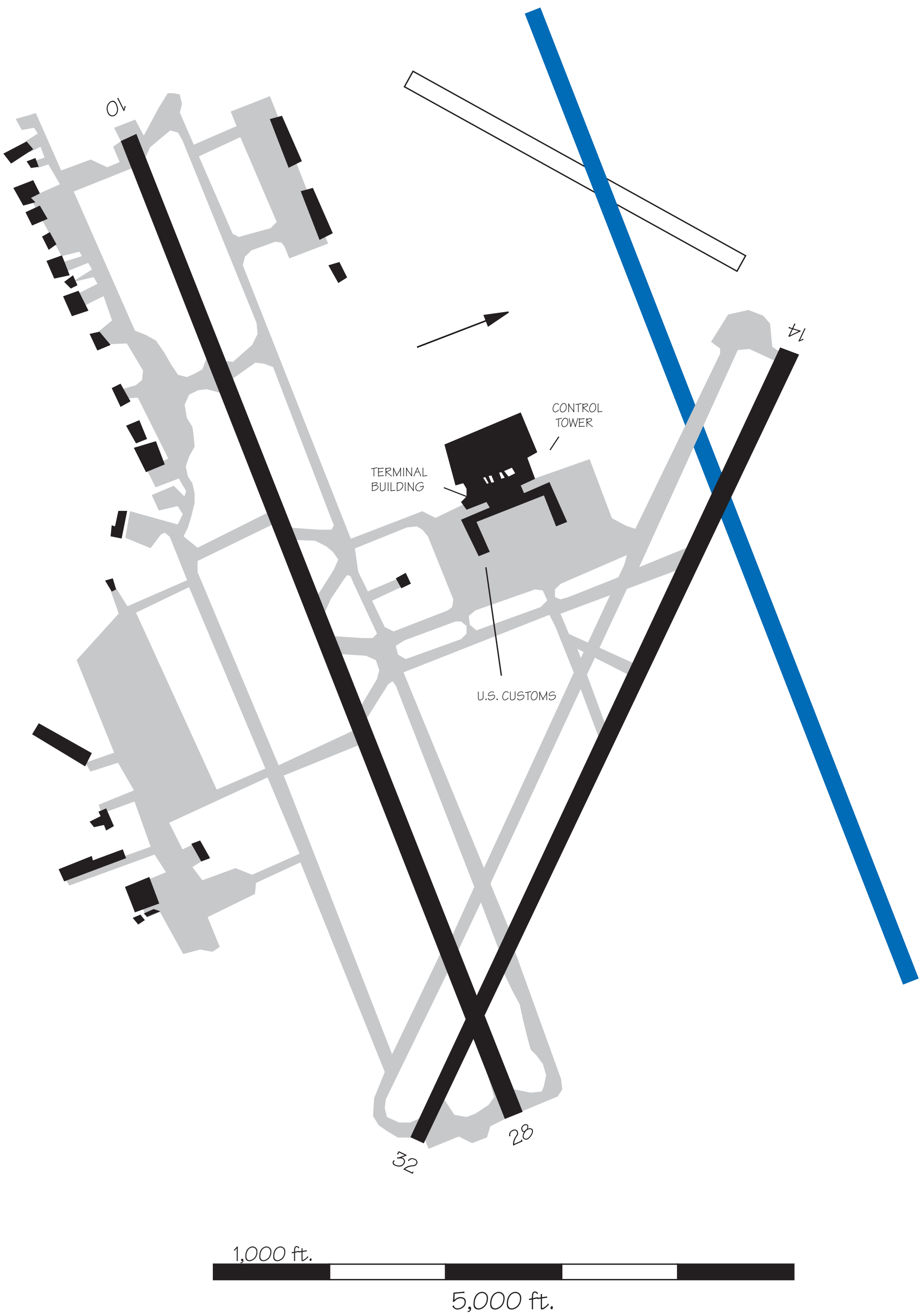
STL — Lambert St. Louis International Airport

A new parallel Runway 12R/30L has been recommended in the St. Louis Airport Master Plan Update. The new plan calls for a parallel runway supporting independent IFR operations. An EIS is also underway. The Master Plan Update and the EIS are anticipated to be completed in late 1997, and construction could begin in 1998.



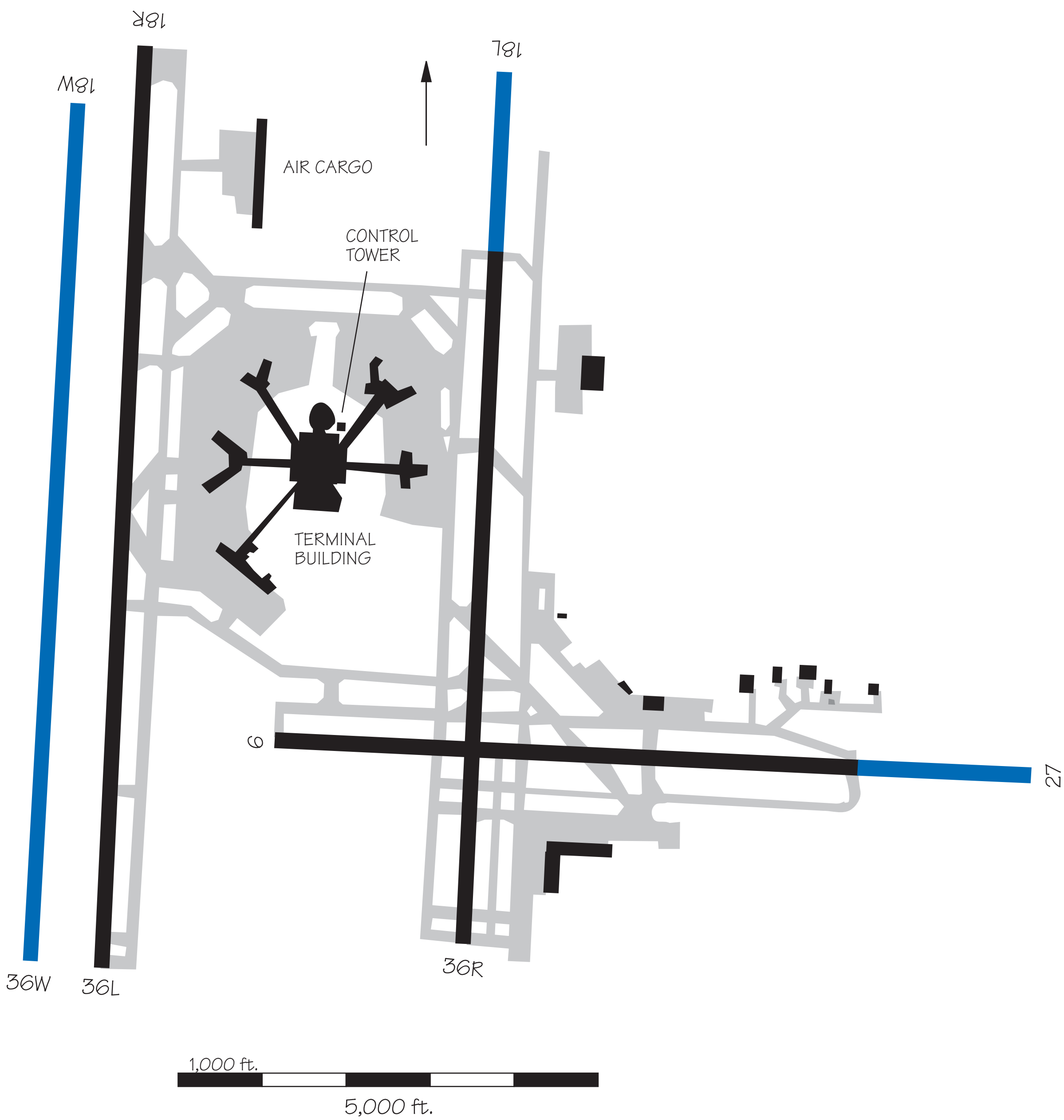
SYR — Syracuse Hancock International Airport

A new parallel Runway 10L/28R, 9,000 feet long and separated from the existing Runway 10/28 by 3,400 feet is being considered. It would provide independent parallel IFR operations, doubling hourly IFR arrival capacity. The expected operational date is 2000. The cost of construction is estimated to be $55 million for the first phase of the new runway, which would be 7,500 feet long, including a parallel taxiway and connections to the ramp. The final length of the runway will be 9,000 feet.



TPA — Tampa International Airport

A third parallel Runway 18W/36W 9,650 feet long and 700 feet west of Runway 18R/36L is being considered. An extension of Runway 18L is also being considered for the time frame beyond 2005, and reconstruction and extension of Runway 27, for the time frame beyond 2010.

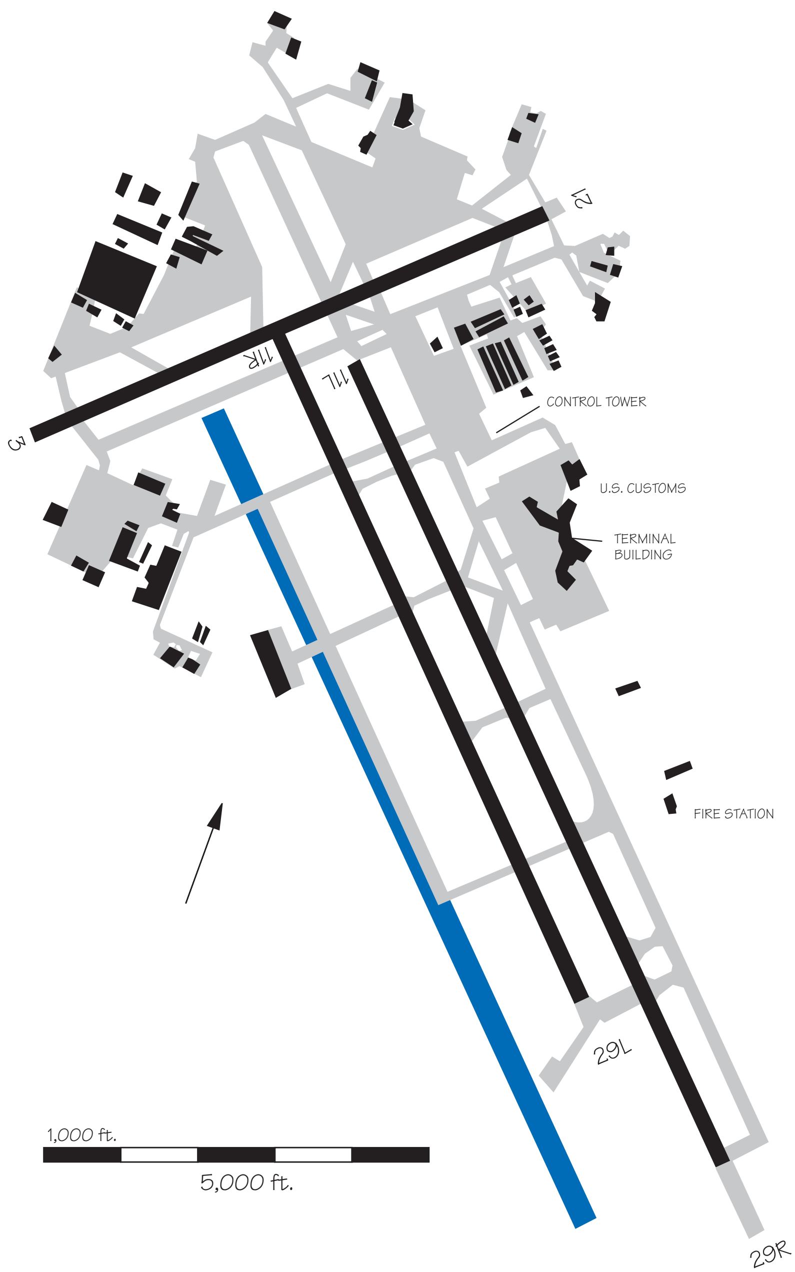


TUL — Tulsa International Airport

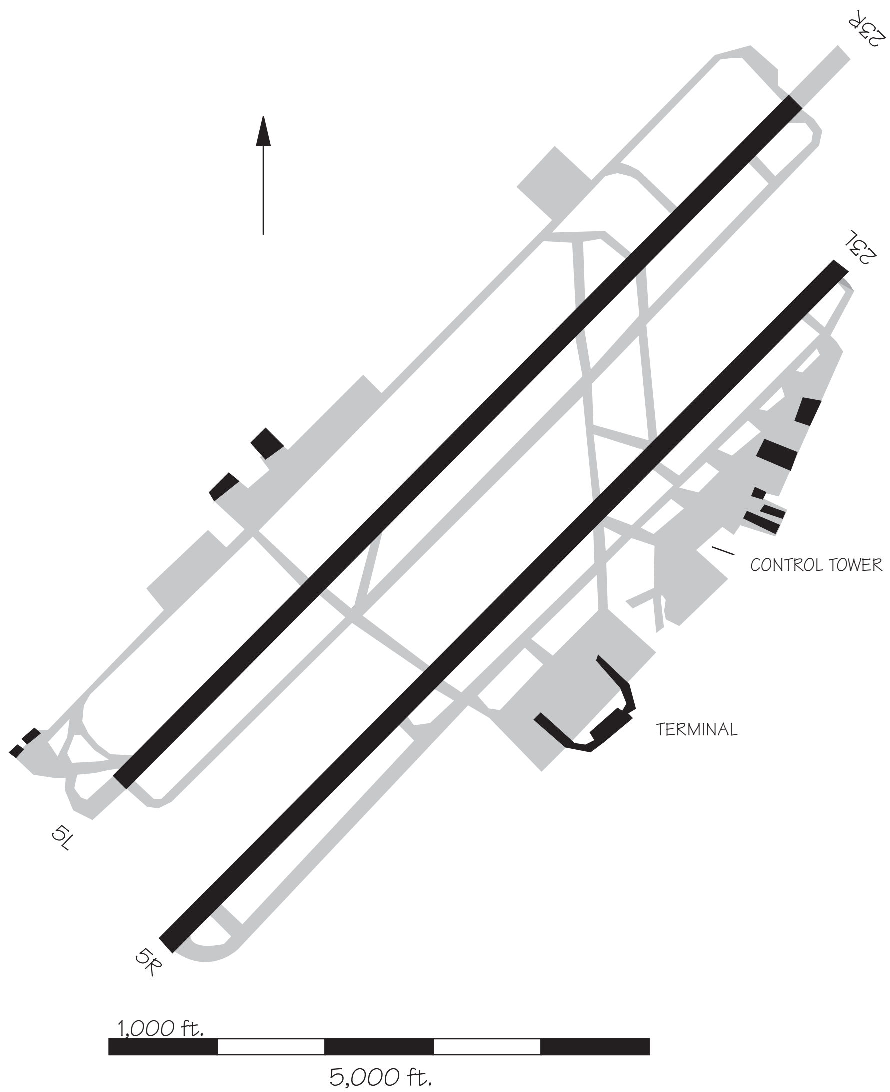
A new parallel runway, Runway 18L/36R, located 6,400 feet east of the present 18L/36R and 9,600 feet long, is being considered. The new runway would permit IFR triple independent approaches, if approved, to Runways 18L, 18C, and 18R.

TUS — Tucson International Airport

An additional parallel air carrier runway, Runway 11R/29L, has been proposed. Upon completion of the new runway, the current Runway 11R/29L, a general aviation runway, will revert to its original taxiway status. It is not anticipated that the sponsor will proceed before 1998. Current plans call for construction to start in 2003 to be operational in 2005. The cost of construction is estimated to be $30 million.



TYS — Knoxville McGhee-Tyson Airport



APPENDIX C: GLOSSARY

AAC .... Advanced AERA Concepts
AAP .... Advanced Automation, FAA
AAS .... Advanced Automation System
ACARS .... ARINC Communications Addressing and Reporting System
ACCC .... Area Control Computer Complex
ACD .... Engineering, Research and Development Service, FAA
ACE .... Airport Capacity Enhancement
ACF .... Area Control Facility
ADR .... Automated Demand Resolution
ADS .... Automatic Dependent Surveillance
ADSIM .... Airfield Delay Simulation Model
AERA .... Automated En Route Air Traffic Control
AEX .... Automated Execution
AF .... Airway Facilities
AFB .... Air Force Base
AGFS .... Aviation Gridded Forecast System
AGL .... Above Ground Level
AIP .... Airport Improvement Program
AIRNET .... Airport Network Simulation Model
AIV .... Aviation Impact Variable
ALP .... Airport Layout Plan
ALS .... Approach Lighting System
ALSF-II .... Approach Light System with Sequenced Flashers and CAT II modification
AMASS .... Airport Movement Area Safety System
AMSS .... Aeronautical Mobile Satellite Service
ANA .... Program Director for Automation, FAA
AND .... Associate Administrator for NAS Development, FAA
ANG .... Air National Guard
ANN .... Program Director for Navigation and Landing, FAA
ANR .... Program Director for Surveillance, FAA
ANS .... NAS Transition Implementation Service, FAA
ANW .... Program Director for Weather and Flight Service Stations, FAA
AOC .... Aeronautical Operational Control
AOR .... Operations Research Service, FAA
APO .... Office of Aviation Policy and Plans, FAA
APP .... Office of Airport Planning and Programming, FAA
ARD .... Research and Development Service, FAA
ARF .... Airport Reservation Function
ARINC .... Aeronautical Radio Incorporated
ARSA .... Airport Radar Surface Area
ARTCC .... Air Route Traffic Control Center

ARTS .... Automated Radar Terminal System
ASC .... Office of System Capacity and Requirements, FAA
ASCP .... Aviation System Capacity Plan
ASD .... Aircraft Situation Display
ASDE .... Airport Surface Detection Equipment
ASE .... NAS System Engineering Service, FAA
ASOS .... Automated Surface Observation System
ASP .... Arrival Sequencing Program
ASQP .... Airline Service Quality Performance
ASR .... Airport Surveillance Radar
ASTA .... Airport Surface Traffic Automation
ATC .... Air Traffic Control
ATCAA .... Air Traffic Control Assigned Airspace
ATCSCC .... Air Traffic Control System Command Center
ATIS .... Automated Terminal Information Service
ATN .... Aeronautical Telecommunications Network
ATMS .... Advanced Traffic Management System
ATO .... Air Traffic Operations Service, FAA
ATOMS .... Air Traffic Operations Management System
AWDL .... Aviation Weather Development Laboratory
AWOS .... Automated Weather Observing System
AWPG .... Aviation Weather Products Generator
BRAC .... Base Realignment Closure Program
CAA .... Civil Aviation Authority
CAEG .... Computer Aided Engineering Graphics
CARF .... Central Altitude Reservation Function
CASA .... Controller Automated Spacing Aid
CASTWG .... Converging Approach Standards Technical Working Group
CAT .... Category
CDTI .... Cockpit Display of Traffic Information
CFWSU .... Central Flow Weather Service Unit
CIP .... Capital Investment Plan
CNS .... Communication, Navigation, and Surveillance
CODAS .... Consolidated Operations and Delay Analysis System
CONDAT .... CONUS National Airspace Data Access Tool
CONUS .... Continental United States
CRDA .... Converging Runway Display Aid
CRS .... Computer Reservation System
CSD .... Critical Sector Detector
CTAS .... Center–TRACON Automation System
CTMA .... Center Traffic Management Advisor
CTR .... Civil Tilt Rotor
CVFP .... Charted Visual Flight Procedures
CW .... Continous Wave

CWSU .... Center Weather Service Unit
CY .... Calendar Year
DA .... Descent Advisor
DDAS .... Daily Decision Analysis System
DEMVAL .... Demonstration/Validation
DGPS .... Differential GPS
DH .... Decision Height
DLP .... Data Link Processor
DME .... Distance Measuring Equipment
DME/P .... Precision Distance Measuring Equipment
DOD .... Department of Defense
DOT .... Department of Transportation
DOTS .... Dynamic Ocean Tracking System
DSB .... Double Sideband
DSP .... Departure Sequencing Program
DSUA .... Dynamic Special-Use Airspace
DVOR .... Doppler VOR
ECVFP .... Expanded Charted Visual Flight Procedures
EDP .... Expedite Departure Path
EDPRT .... Expert Diagnostic, Predictive, and Resolution Tool
EFF .... Experimental Forecast Facility
EIS .... Environmental Impact Statement
EOF .... Emergency Operations Facility
ESP .... En Route Spacing Program
ETMS .... Enhanced Traffic Management System
EVAS .... Enhanced Vortex Advisory System
F&E .... Facilities and Equipment
FAA .... Federal Aviation Administration
FAATC .... Federal Aviation Administration Technical Center
FADE .... FAA-Airline Data Exchange
FAF .... Final Approach Fix
FANS .... Future Air Navigation System
FAST .... Final Approach Spacing Tool
FBO .... Fixed Base Operator
FDAD .... Full Digital ARTS Display
FL .... Flight Level
FLOWALTS .... Flow Generation Function
FLOWSIM .... Traffic Flow Planning Simulation
FMA .... Final Monitor Aid
FMS .... Flight Management System
FSD .... Full-Scale Development
FSM .... Flight Simulation Monitor
FT .... Feet

FTMI .... Flight Operations and Air Traffic Management Integration
FY .... Fiscal Year
GA .... General Aviation
GAO .... General Accounting Office
GDP .... Gross Domestic Product
GLONASS .... Global Orbiting Navigational Satellite System
GNSS .... Global Navigation Satellite System
GPS .... Global Positioning System
GRADE .... Graphical Airspace Design Environment
HARS .... High Altitude Route System
HIRL .... High Intensity Runway Lights
HUD .... Heads-Up Display
HF .... High Frequency
ICAO .... International Civil Aviation Organization
IFCN .... Inter-Facility Flow Control Network
IFR .... Instrument Flight Rules
I-LAB .... Integration and Interaction Laboratory
ILS .... Instrument Landing System
IMC .... Instrument Meteorological Conditions
INMARSAT .... International Maritime Satellite
IOC .... Initial Operational Capability
ISSS .... Initial Sector Suite System
ITS .... Intelligent Tutoring System
ITWS .... Integrated Terminal Weather System
LDA .... Localizer Directional Aid
LIP .... Limited Implementation Program
LLWAS .... Low Level Wind Shear Alert System
LORAN .... Long Range Navigation
MA .... Monitor Alert
MALSR .... Medium Intensity Approach Lighting System with RAIL
MAP .... Military Airport Program
MAP .... Missed Approach Point
MASPS .... Minimum Aviation System Performance Standards
MCAS .... Marine Corps Air Station
MCF .... Metroplex Control Facility
MDCRS .... Meteorological Data Collection and Reporting System
MIT .... Miles In Trail
MLS .... Microwave Landing System
MNPS .... Minimum Navigation Performance Specifications
MOA .... Military Operations Area
MOPS .... Minimum Operations Performance Standards
MRAD .... Milli-Radian
MWP .... Meteorologist Weather Processor
NAS .... Naval Air Station

NAS .... National Airspace System
NASP .... NAS Plan
NASPAC .... NAS Performance Analysis Capability
NASPALS .... NAS Precision Approach and Landing System
NASSIM .... NAS Simulation Model
NATSPG .... North Atlantic Special Planning Group
NAVAID .... Navigational Aid
NCF .... National Control Facility
NCP .... NAS Change Proposal
NEXRAD .... Next Generation Weather Radar
NFDC .... National Flight Data Center
NMC .... National Meteorological Center
NMCC .... National Maintenance Coordination Complex
NM .... Nautical Mile
NOAA .... National Oceanic and Atmospheric Administration
NPIAS .... National Plan of Integrated Airport Systems
NSC .... National Simulation Capability
NTP .... National Transportation Policy
NTZ .... No Transgression Zone
NWS .... National Weather Service
OAG .... Official Airline Guide
ODALS .... Omni-Directional Approach Lighting System
ODAPS .... Oceanic Display and Planning System
ODF .... Oceanic Development Facility
ODL .... Oceanic Data Link
OMB .... Office of Management and Budget
OPTIFLOW .... Optimized Flow Planning
ORD .... Operational Readiness Date
ORD .... Operational Readiness Demonstration
OST .... Office of the Secretary of Transportation
OTFP .... Operational Traffic Flow Planning
OTPS .... Oceanic Traffic Planning System
PADS .... Planned Arrival and Departure System
PAPI .... Precision Approach Path Indicator
PCA .... Positive Control Airspace
PDC .... Pre-Departure Clearance
PRM .... Precision Runway Monitor
R&D .... Research and Development
RE&D .... Research, Engineering, and Development
RAIL .... Runway Alignment Indicator Lights
RDSIM .... Runway Delay Simulation Model
REIL .... Runway End Identifier Lights
RFP .... Request for Proposal
RGCSP .... Review of General Concepts of Separation Panel

RMM .... Remote Maintenance Monitoring
RMP .... Rotorcraft Master Plan
RNAV .... Remote Area Navigation
RNP .... Required Navigation Performance
RNPC .... Required Navigation Performance Capability
ROT .... Runway Occupancy Time
RSLS .... Runway Status Light System
RTCA .... Radio Technical Commission for Aeronautics
RVR .... Runway Visual Range
SAR .... System Analysis Recording
SARPS .... Standards and Recommended Practices
SATCOM .... Satellite Communications
SCIA .... Simultaneous Converging Instrument Approaches
SDAT .... Sector Design Analysis Tool
SDRS .... Standardized Delay Reporting System
SE .... Strategy Evaluation
SID .... Standard Instrument Departure
SIMMOD .... Airport and Airspace Simulation Model
SM .... Statute Mile
SMARTFLOW ..... Knowledge-Based Flow Planning
SMGC .... Surface Movement Guidance and Control
SMS .... Simulation Modeling System
SOIR .... Simultaneous Operations on Intersecting Runways
SOIWR .... Simultaneous Operations on Intersecting Wet Runways
STAR .... Standard Terminal Arrival Route
SUA .... Special Use Airspace
TACAN .... Tactical Air Navigation
UHF .... omnidirectional course and distance information
TASS .... Terminal Area Surveillance System
TATCA .... Terminal ATC Automation
TAVT .... Terminal Airspace Visualization Tool
TCA .... Terminal Control Area
TCAS .... Traffic Alert and Collision Avoidance System
TCCC .... Tower Control Computer Complex
TDP .... Technical Data Package
TERPS .... Terminal Instrument Procedures
TFM .... Traffic Flow Management
TIDS .... Tower Integrated Display System
TMA .... Traffic Management Advisor
TMCC .... Traffic Management Computer Complex
TMS .... Traffic Management System
TMU .... Traffic Management Unit
TRACON .... Terminal Radar Approach Control
TSC .... Volpe Transportation Systems Center

TSO .... Technical Standard Order
TTMA .... TRACON Traffic Management Advisor
TVOR .... Terminal VOR
TWDR .... Terminal Weather Doppler Radar
USWRP .... U.S. Weather Research Program
VASI .... Visual Approach Slope Indicators
VF .... Vertical Flight
VFR .... Visual Flight Rules
VHF .... Very High Frequency
VMC .... Visual Meteorological Conditions
VOR .... VHF Omnidirectional Range — course information only
VORTAC .... Combined VOR and TACAN Navigational Facility
VOT .... VOR Test
WAAS .... Wide Area Augmentation System

APPENDIX D: SURVEY

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1997 Aviation Capacity Enhancement Plan Questionnaire

What is your industry affiliation and division:

____ FAA ____________________
____ Airline ____________________
____ Airport ____________________
____ Airport Planning ____________________
____ NASA ____________________
____ Military ____________________
____ Airport Services ____________________
____ Other Gov't ____________________

____ Trade Organization (e.g., ATA, AOPA, etc.) ____________________
____ University ____________________
____ Professional Society (e.g., AIAA, AAAE, etc.) ____________________
____ Research ____________________
____ Aircraft Manufacturer ____________________
____ Other Industry ____________________
____ Other ____________________

What is your primary use of the Aviation Capacity Enhancement Plan?

(Check all that apply)

____ Planning purposes
____ Background information
____ Other ____________________
____ Reference information
____ Project status information

Which of the following Chapters or Appendicies do you use, and do you find them beneficial?

(Please rate them on a scale of 1 to 5, 1 being lowest, 5 highest.)

Topic	Don't Use	Do Use	1	2	3	4	5
Chapter 1: The National Airspace System	❏	❏	❏	❏	❏	❏	❏
Chapter 2: Major Capacity Initiatives	❏	❏	❏	❏	❏	❏	❏
Chapter 3: Airport Development	❏	❏	❏	❏	❏	❏	❏
Chapter 4: Airspace Development	❏	❏	❏	❏	❏	❏	❏
Chapter 5: New Operational Procedures	❏	❏	❏	❏	❏	❏	❏
Chapter 6: Capacity Enhancing Technologies	❏	❏	❏	❏	❏	❏	❏
Appendix A: Top 100 Airports Data	❏	❏	❏	❏	❏	❏	❏
Appendix B: Top 100 Airports Diagrams	❏	❏	❏	❏	❏	❏	❏
Appendix C: Glossary	❏	❏	❏	❏	❏	❏	❏
Appendix D: Index	❏	❏	❏	❏	❏	❏	❏

How often have you received the Aviation Capacity Enhancement Plan?

____ Every year
____ Not always
____ Only once or twice in the past
____ Never before

How often do you use the Plan in your work?

____ Weekly
____ Monthly
____ Occasionally during the year
____ About once a year
____ Never

Does the information in the Plan agree with your own local experience?

What important information should the Plan contain that it currently does not?

What format is your copy of the 1997 ACE Plan?

____ Print

____ Electronic, from the CD-ROM

____ Electronic, from the world wide web

In the future, what format would you like to receive the Aviation Capacity Enhancement Plan?

____ Print

____ Electronic, from the CD-ROM

____ Electronic, from the world wide web

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Federal Aviation Administration
Office of System Capacity
800 Independence Ave., SW
Washington, DC 20591

Attn: 1997 ACE Plan Survey

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